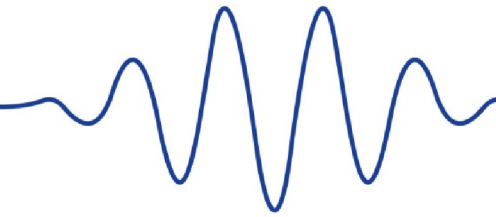




Radio Society of Great Britain

Advancing amateur radio since 1913



Amateur radio syllabus - Intermediate level

	Section 1 — Licensing conditions and station identification
	Nature of amateur radio, types of licence and call signs
1A4	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.
	Operators and supervision
1B1	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. <i>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.</i>
1B2	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. <i>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.</i>
	Messages
1C1	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.
1C2	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. <i>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.</i>

	Apparatus, inspection and closedown
1D1	<p>Recall that transmissions from the station must not cause undue interference to other radio users.</p> <p>Recall that the Licensee must reduce any emissions causing interference, to the satisfaction of a person authorised by Ofcom.</p> <p>Understand that this may include a reduction in transmit power or any other action required to reduce emissions to an acceptable level.</p>
1D2	<p>Recall the occasions for mandatory log keeping.</p> <p>Understand circumstances in which modification or cessation of operating of the station may be required.</p> <p>Understand circumstances in which modification of transmitting equipment may be required.</p>
	Unattended and remote control operation
1E1	<p>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.</p> <p>Recall that unattended operation does not include providing for general use by other amateurs.</p>
1E2	<p>Recall that the licensee may conduct Remote Control operation of the main station in a manner consistent with the terms the Licence.</p> <p>Recall that the Remote Control link must be by radio in an amateur band, limited to 500mW pep e.r.p. maximum transmit power.</p> <p>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.</p> <p>Recall that Remote Control operation does not include providing for general use by other amateurs.</p>
	CEPT and international
1F1	<p>Recall that other Administrations (foreign countries) do not routinely recognise the Intermediate Licence.</p>
	Licence schedule
1G1	<p>Identify relevant information in Schedule 1 to the Intermediate licence.</p> <p><i>A copy of the relevant part of Schedule 1 will be available during the examination.</i></p>
1G2	<p>Recall</p> <ul style="list-style-type: none"> • the average and peak transmit power level at which the EMF restrictions apply; • when there is a need to reassess EMF compliance.

	Section 2 — Technical aspects
	Fundamental theory
2A1	Recall that components have tolerances, and that the measured value of a component may not precisely agree with its marked value.
	Resistance
2C1	<p>Understand circuits comprising series and parallel connections of resistors and cells.</p> <p>Calculate the value of any one of the three quantities (V, I or R) given the other two.</p> <p>Calculate the combined resistance of two or three resistors in series and/or parallel.</p> <p><i>Resistors of different values may be used in series or parallel or combined series parallel circuits.</i></p> <p><i>The prefixes milli and kilo may be involved for some of these calculations.</i></p>
2C2	<p>Understand that two or three resistors can be arranged to act as a potential divider and apply the formula.</p> <p><i>The prefixes milli and kilo may be involved for some of these calculations.</i></p>
2C3	<p>Understand the difference between potential difference (PD) and electromotive force (EMF).</p> <p>Understand the concept of source resistance (impedance) and voltage drop due to current flow.</p>
	Reactive components
2D1	<p>Recall that a capacitor normally consists of two metal plates separated by an insulating material and that its capacitance is measured in Farads.</p> <p>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).</p>
2D2	Understand and apply the formulae for calculating the combined values of two or three capacitors in series and in parallel.
2D3	Recall that some capacitors e.g. electrolytic are polarised and must be correctly connected to avoid injury, damage or destruction.
2D4	<p>Understand the relative movement of a conductor in a magnetic field will induce a voltage across the ends of the conductor.</p> <p>Recall that a current passing through a wire forms a magnetic field around the wire.</p> <p>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.</p> <p>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.</p>

2D5	Understand and apply the formulae for calculating the combined values of two or three inductors in series and in parallel.
2D6	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.
	AC theory
2E1	Understand that by repeatedly charging and discharging in alternate directions, a capacitor can pass alternating currents, but cannot pass a direct current.
2E2	Understand the sinusoidal curve as a graphical representation of the rise and fall of 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. Recall the concept of phase difference between two signals, and that it can be expressed in degrees.
2E3	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, $V_{rms} = 0.707 \times V_p$ (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° .
2E4	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.
2E5	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.

<p>2E6</p>	<p>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.</p> <p>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.</p> <p>Recall impedance is measured in ohms.</p> <p><i>Note: Phase and vector notation is NOT included at this level.</i></p>
<p>2E7</p>	<p>Recall and manipulate the formula $v = f \times \lambda$.</p> <p>Calculate frequency or wavelength given the other parameter.</p> <p><i>The velocity of radio waves will be given in the Reference Booklet.</i></p>
<p>2E8</p>	<p>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.</p>
	<p>Digital signals</p>
<p>2F1</p>	<p>Recall that digital signals with more bits and/or increased sampling rate enables a more accurate representation of the analogue signal.</p> <p>Recall that the error introduced by sampling the analogue signal to produce the digital signal is a form of distortion.</p> <p>Recall that the minimum sampling rate needs to be greater than twice the frequency of the analogue signal to adequately capture the detail of the analogue signal being sampled.</p> <p>Recall that the minimum sampling rate is known as the Nyquist rate.</p>
	<p>Transformers</p>
<p>2G1</p>	<p>Understand that a simple transformer consists of two coils of wire sharing the same magnetic field.</p> <p>Recall that it may have an iron core to concentrate the field.</p> <p>Understand that at higher frequencies (e.g. RF and IF) a ferrite core, rather than an iron core, is used for improved efficiency.</p> <p>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.</p> <p>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</p> <p>Understand that the output from a transformer will always be an alternating current.</p> <p><i>Note: Note that knowledge of the impedance change is not required.</i></p>
	<p>Tuned Circuits and resonance</p>

2H1	<p>Recall that a series or parallel circuit of a capacitor and inductor together forms a tuned circuit.</p> <p>Recall, using graphical methods, that at resonance the reactance of the capacitance will equal the reactance of the inductance, $X_C = X_L$.</p>
2H2	<p>Recall that, at their resonant frequencies, series tuned circuits present a low impedance, whereas parallel tuned circuits present a high impedance.</p> <p>Identify the response curves of impedance vs frequency for series and parallel resonant circuits.</p>
2H3	<p>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.</p> <p>Recall how the resonant frequency depends on the value of capacitance and inductance.</p> <p><i>Note that candidates must know that increasing L or C reduces the resonant frequency and vice-versa.</i></p> <p><i>Knowledge of the resonant frequency formula is not required.</i></p>
2H4	<p>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.</p> <p>Recall that the Q factor of a tuned circuit is an indication of the selectivity of the tuned circuit.</p>
2H5	<p>Identify the circuits of simple low pass, high pass, band pass and band stop (notch) filters and their response curves.</p> <p>Recall, using graphical methods, the concept of the cut-off frequency.</p>
Semiconductor devices	
2I1	<p>Recall that a diode will conduct current in one direction only.</p> <p>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).</p> <p>Understand the use of a diode to produce direct current from an alternating current is known as rectification.</p>
2I2	<p>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.</p>
2I3	<p>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.</p> <p>Understand that the ratio of the collector current to the base current (I_C/I_B) is the current gain β or h_{FE} of the transistor.</p> <p>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.</p> <p><i>Note: the candidate is not required to recall transistor configurations.</i></p> <p><i>Circuits shown will be an NPN transistor connected in common emitter mode.</i></p>

214	<p>Recognise the circuit of a simple common emitter amplifier.</p> <p>Recall that semiconductors must be provided with the correct DC voltages and currents to allow them to function and that this is termed biasing.</p> <p><i>Note that calculations are not required.</i></p>
215	<p>Recall that a transistor can be used to generate audio and radio frequencies by maintaining the oscillations in a tuned or frequency selective circuit.</p> <p>Distinguish between a crystal oscillator and a variable frequency oscillator (VFO) based on a tuned circuit.</p> <p><i>Note: Diagrams will show the Colpitts oscillator with the transistor in emitter follower mode.</i></p> <p><i>Candidates are not expected to recognise other types of oscillator.</i></p>
216	<p>Recall that many individual semiconductor devices may be built on a common substrate and packaged as an integrated circuit (IC).</p> <p>Recall that ICs may provide complete circuit functions, including, amplifiers, oscillators, voltage regulators and digital processing chips in a single package.</p> <p><i>Questions will be limited to the IC applications shown above.</i></p>
	<p>Cells and power supplies</p>
2J1	<p>Recall that different technologies used in cells give different terminal voltages.</p> <p>Recall that battery capacity (stored charge) is measured in Ampere-hours (Ah).</p>
2J2	<p>Recall the circuit diagrams and characteristics of different types of rectifier and smoothing circuit (i.e. half wave, full wave and bridge).</p>
2J3	<p>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.</p> <p>Identify the AC and rectified (pulsed DC) waveforms.</p>
2J4	<p>Identify discrete component and integrated circuit linear power supplies and understand the basic principle of their operation.</p> <p>Recall the relative merits of linear and switched mode power supplies. Size, efficiency, heat, input and output voltage, RFI, cost & weight.</p>
	<p>Section 3 — Transmitters and receivers</p>
	<p>Transmitter concepts</p>
3A2	<p>Recall the meaning of depth of modulation for amplitude modulation.</p> <p>Recall the meanings of wide band and narrow band frequency modulation.</p> <p>Recall the meaning of the term Peak Deviation.</p>

<p>3A3</p>	<p>Understand that single sideband (SSB) is a form of amplitude modulation where one sideband and the carrier have been removed from the transmitted signal.</p> <p>Understand that SSB is more efficient than AM or FM because power is not used to transmit the carrier and the other sideband.</p> <p>Understand that a second advantage is that the transmitted signal takes up only half the bandwidth, e.g. 3kHz not 6kHz.</p> <p>Recall that :</p> <ul style="list-style-type: none"> • 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.
	<p>Transmitter architecture</p>
<p>3B1</p>	<p>Understand the block diagrams of CW, AM, SSB and FM transmitters.</p>
	<p>Oscillators</p>
<p>3C1</p>	<p>Recall and understand the relative advantages and disadvantages of a crystal oscillator and a VFO.</p> <p>Recall that the resonant frequency of the tuned circuit in a VFO determines the frequency of oscillation.</p>
<p>3C2</p>	<p>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.</p> <p>Understand that a lack of stability (drift) may result in operation outside the amateur bands.</p> <p>Recall that most modern oscillators are digital synthesisers, which are very stable and are based on a crystal reference.</p>
<p>3C3</p>	<p>Recall that digital signals can be used to generate audio and RF signals by Direct Digital Synthesis (DDS).</p> <p>Recall the meaning of DDS.</p> <p>Recall that a Direct Digital Synthesiser generates audio and RF signals from pre-set digital values held in a memory, or Lookup Table.</p>
	<p>Microphone amplifiers and modulators</p>
<p>3E1</p>	<p>Recall that a Balanced Modulator is used to produce two sidebands whilst suppressing the carrier.</p>
<p>3E2</p>	<p>Understand that an SSB filter is a Band Pass Filter that will only allow one sideband to pass to the Power Amplifier.</p> <p>Recall that in an analogue transmitter, SSB filters are normally constructed from a number of quartz crystals or other resonators.</p>
<p>3E3</p>	<p>Recall that a variable capacitance diode can be used in an oscillator to produce frequency modulation (FM).</p>

	RF power amplifiers
3F1	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.
	Transmitter interference
3G2	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.
3G3	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. Understand that a low-pass filter, a band-pass filter and a band stop (notch) filter can minimise the radiation of harmonics. Recall that RF power amplifiers can produce harmonics of the wanted signals and that suitable filtering is required to avoid harmonic radiation.
3G4	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.
3G5	Recall the cause and effect of 'chirp' and identify suitable remedies.
	Receiver concepts
3H2	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	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.
3H4	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. <i>See also Section 2H4.</i>
	Superheterodyne concepts
3I1	Understand the need for and advantages of the superheterodyne architecture. <i>Note: A diagram of the Single Conversion Superhet diagram is provided in section 4.</i>
3I2	Recall that the intermediate frequency is the sum of or difference between the RF and local oscillator frequencies and is produced by a mixer.

313	<p>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.</p> <p>Understand that tuned circuits in RF and IF amplifiers select the wanted signal. Identify the tuned circuits in the circuit of an IF amplifier.</p>
	Demodulation
3K1	<p>Understand how a diode detector will recover the audio from amplitude modulated signals.</p> <p>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.</p> <p>Identify the waveforms produced in a diode AM detector.</p>
	Automatic gain control (AGC)
3L1	<p>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.</p> <p>Recall that the AGC signal can also drive a signal strength meter (S-meter).</p>
	SDR transmitters and receivers
3M1	<p>Recall that SDR software uses a mathematical function called a Fourier transform which sifts the composite signal into its constituent independent frequencies for processing.</p> <p>Recall that this can also be used to provide a spectrum or waterfall display.</p> <p>Recall that digital filters can be much more selective than analogue filters.</p>
3M2	<p>Recall the meaning of the time domain and the frequency domain.</p> <p>Understand how signals in the time domain may also be viewed in the frequency domain.</p> <p>Identify for some simple harmonic waves, the spectrum obtained using the Fourier transform.</p> <p><i>(Waves composed of one and two Harmonics will be examined).</i></p>
3M3	<p>Recall the different elements that make up the functions of an SDR (block diagram).</p>

	Section 4 – Feeders and antennas
	Feeders
4A1	<p>Understand the equal and opposite currents flowing in a balanced feeder cause equal and opposite fields around the two conductors.</p> <p>Understand that these fields cancel out, but that nearby objects can cause an imbalance that makes the feeder radiate RF energy.</p> <p>Recall that a rectangular waveguide must have its larger dimension greater than $\lambda/2$ for the signal to travel.</p>
4A2	<p>Recall that twin feeder usually has lower loss than coaxial cable.</p> <p>Recall that loss is measured in dB.</p> <p>Understand the relationship between RF output power, feeder loss and power delivered to the antenna.</p> <p>Calculate the unknown quantity given the other two.</p> <p><i>Feeder loss will be in multiples of 3dB and 10dB.</i></p>
4A3	<p>Recall that feeders have a characteristic impedance which depends upon the diameter and spacing of the conductors.</p> <p>Recall that this impedance determines the ratio of the RF RMS potential difference to the RF, RMS current in a correctly terminated feeder.</p> <p>Recall that for amateur use 50 Ω coaxial feeder is normally used; that coaxial cable for TV and satellite receivers has a different impedance of 75 Ω.</p> <p>Recall that balanced feeder is commonly available from 75 Ω to 600 Ω.</p> <p>Recall that correctly terminated means correctly connected with a resistive load equal to the cable characteristic impedance.</p>
	Baluns
4B1	Recall the construction and use of choke type baluns
	Antenna concepts
4C2	<p>Understand the front-to-back ratio of an antenna.</p> <p>Understand the beam width of an antenna.</p> <p>Understand that radiation patterns exist in three dimensions.</p>
4C4	<p>Recall that an isotropic radiator is a theoretical antenna that radiates equally in all directions.</p> <p>Recall the Effective Isotropic Radiated Power (EIRP) is based on an isotropic antenna reference rather than a dipole and is expressed in dBi.</p> <p>Recall that a half-wave dipole has a gain, in its optimum direction, of 2.15dBi</p>
4C5	<p>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.</p> <p>Recall the effect of the ground on the angle of radiation.</p>

4C6	<p>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 $73\ \Omega$ in free space and that under practical conditions (e.g. due to ground proximity effects) this will be approximately $50\ \Omega$ when used at its designed frequency.</p>
	<p>Types of antenna</p>
4D1	<p>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.</p> <p>Recall that Yagi antennas may have more than one director.</p>
4D2	<p>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.</p> <p>Recall that this technique may be extended to multielement antennas such as Yagis.</p>
	<p>Standing waves</p>
4E1	<p>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.</p> <p>Recall that both forward and reflected signals are subjected to feeder loss.</p> <p>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.</p>
	<p>Antenna matching units</p>
4F1	<p>Recall that a transmitter is designed to transfer energy into a specific impedance.</p> <p>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.</p> <p>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.</p>
	<p>Plugs and Sockets</p>
4G1	<p>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.</p> <p><i>Note that correctly connected means screen and inner conductor continuity through any plug and socket.</i></p>

	Section 5 – Propagation
	Radio propagation: key concepts
5A2	<p>Understand the meaning of ground wave, tropospheric (space) wave, sky wave, skip distance and skip zone (dead zone).</p> <p>Understand why the ground wave has a limited range due to absorption of energy in the ground and that the loss increases with increasing frequency.</p>
5A3	<p>Recall that electromagnetic radiation comprises both an electrical field and a magnetic field.</p> <p>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.</p> <p>Recall that it is the plane of polarisation of the electric field that defines the polarisation of the electromagnetic wave.</p>
	Ionosphere
5B1	<p>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.</p> <p>Recall the ionospheric layers (D, E, F1 and F2) and approximate heights.</p>
5B2	<p>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.</p> <p>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.</p> <p>Recall that the highest frequency that will be refracted over a given path is known as the maximum usable frequency (MUF).</p>
5B3	<p>Recall that the F2 layer provides the furthest refractions for HF signals (about 4000km) and that the F layers combine at night.</p> <p>Recall that multiple hops permit worldwide propagation.</p> <p>Understand how fading occurs and its effect on the received signal.</p> <p>Recall that Short Path ionospheric propagation of HF signals is the most direct route around the earth.</p> <p>Recall that Long Path ionospheric propagation is where HF signals are received via the opposite route around the earth to the Short Path.</p>
5B4	<p>Recall that the D layer tends to absorb the lower radio frequencies during daylight hours and that it tends to disappear at night.</p> <p>Recall that the lowest frequency that can pass through the D-layer without significant absorption is the lowest usable frequency (LUF).</p> <p>Understand that if the D-layer absorption (LUF) occurs at frequencies higher than the MUF then no ionospheric propagation can occur.</p>

5B5	<p>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).</p> <p>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.</p>
	VHF and above
5C3	<p>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.</p>
	Section 6 – Electro magnetic compatibility (EMC)
	EMC concepts
6A1	<p>Understand that all electronic equipment is capable of radiating and absorbing radio frequency energy.</p> <p>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.</p>
6A2	<p>Recall that the immunity of a device can often be improved by screening and filtering power, signal and control leads.</p>
6A3	<p>Understand that transmitters in domestic environments may give rise to RF fields stronger than the agreed limits.</p> <p>Understand that transmitters in domestic environments are not normal situations and special measures may have to be taken.</p>
6A4	<p>Understand that new electronic equipment should meet the British Standards Institute immunity requirements but that existing equipment and poorly installed equipment may not.</p>
	Sources of interference and their effects
6B1	<p>Recall that speech transmissions, particularly AM and SSB may cause speech like sounds in analogue radio, audio systems and telephones.</p> <p>Recall that FM transmission is more likely to mute or reduce the volume of the wanted signals (audio or RF).</p>

6B2	<p>Recall non-radio sources of interference and their effects:</p> <ul style="list-style-type: none"> • 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 <p>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.</p>
6B3	<p>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.</p>
	<p>Routes of entry</p>
6C1	<p>Recall that direct pick up in affected devices tends to be independent of a specific frequency within a band although differences may be noticed between different bands.</p> <p>Recall that direct pickup is especially an issue in the VHF/UHF bands.</p>
6C2	<p>Understand that some masthead and down-lead TV amplifiers are broadband, amplifying a wide range of frequencies, including amateur frequencies.</p> <p>Understand that this can result in overloading of the amplifier and/or the TV input.</p>
	<p>Filtering and remedial measures</p>
6D1	<p>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.</p> <p>Recall the use of ferrite ring filters for minimising unwanted RF on antenna down-leads and mains leads to affected equipment.</p> <p>Recall and understand the use of high-pass or lowpass filters to reduce the level of HF and VHF amateur transmissions into other electronic equipment.</p> <p>Understand the use of mains filters to reduce RF, electric motor and thermostat interference to TV, radio and audio systems.</p>
6D2	<p>Understand the meanings of common mode and differential mode currents and signals.</p> <p>Understand how a ferrite ring or choke can be used to attenuate common mode signals in twin wires and braid currents on coaxial cables.</p>
6D3	<p>Recall how to use a suitable general coverage receiver to check for spurious and harmonic emissions from the station.</p>

6D4	<p>Understand the use of a dummy load in fault finding.</p> <p>Recall that the resistor(s) used in a dummy load must be non-reactive and of a suitable power rating.</p> <p>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.</p>
	Station design and antenna placement/general principles
6E1	Recall how to interconnect the transmitter, microphone, power supply, SWR meter and band or low pass filters, using appropriate cables, to minimise EMC problems.
6E2	Recall what constitutes a good RF earth, its purpose and use.
6E3	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.
	Station design and antenna placement/mobile installations
6F2	<p>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.</p> <p>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.</p>
6F3	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.
	Section 7 – Operating practices and procedures
	Good operating practices and procedures
7A3	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	<p>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.</p> <p>Recall that amateur radio contests require the exchange of information such as signal report, serial number and location.</p> <p>Recall that contests often have sections for different bands, power levels and modes.</p>

	Band plans
7B1	<p>Recall that band plans are produced by the IARU.</p> <p>Recall that the band plans state that:</p> <p>no SSB operation should take place in the 10MHz (30m) band</p> <p>no contests shall be organised in the 5MHz (60m), 10MHz (30m), 18MHz (17m) and 24MHz (12m), bands</p> <p>transmissions on satellite frequencies should be avoided for terrestrial contacts.</p> <p><i>Note: The 5MHz (60m) band is NOT available to Intermediate Licence holders. Questions on beacon and satellite frequencies will be limited to the 14MHz (20m) and 144MHz (2m) bands.</i></p> <p><i>A copy of the relevant band plans will be available during the examination but may not be ones in current use.</i></p> <p><i>Reference Booklets containing examination band plans are available on the RSGB web site.</i></p>
	Codes and abbreviations
7E1	<p>Recall the meaning and the reason for use of the Q codes: QRM, QRN, QRO, QRP, QRT, QSB, QSL, QSO, QSY, QTH.</p>
	Digital interfaces
7F2	<p>Recall that several types of transmissions can be generated and received with the use of a personal computer and a suitable interface.</p> <p>Recall minimal distortion can be obtained by careful adjustments between the DAC interface and the transmitter.</p> <p>Recall other programs running on the PC that is handling the transmitter or receiver audio may cause interference e.g. warning beeps and alerts.</p>
	Satellites
7G1	<p>Recall that satellites orbit the Earth at heights above 250km and understand that most amateur satellites are moving in relation to the Earth and will only be above the horizon at certain times.</p>
7G2	<p>Recall that the up-link and down-link frequencies are generally in different amateur bands and that details are published by amateur organisations.</p> <p>Recall that the transmitting station must be able to receive both the up-link and down-link signals.</p>
7G3	<p>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.</p>
7G4	<p>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.</p>

	Section 8 – Safety
	Electricity
8A1	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.
8A4	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. <i>For mains: current = power/230 where 230 is the nominal mains voltage.</i>
8A6	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.
8A8	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
8B2	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	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.
8B4	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	Understand that using a centre punch will help prevent a drill bit slipping.
8B6	Understand the reasons why a bench-mounted pillar drill is safer than a hand-held drill.

	Working with RF
8D1	<p>Recall that at 50W transmit power, especially with higher gain antennas, the EMF compliance distance can be several metres.</p> <p>Recall that, when mobile, pedestrians might be inside the EMF compliance distance.</p> <p>Recall that in such situations, especially when stationary, transmission must cease.</p> <p><i>For example: 50W continuous FM into a 4 element Yagi gives an EMF compliance distance of around 7m.</i></p> <p><i>When mobile with 50W into a modest roof-mount antenna (3dBi) the EMF compliance distance is around 3m.</i></p>
	Lightning
8E1	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.
	Section 9 – measurements and construction
	Measurements
9A1	Recall the purpose of a multimeter and understand how to set the meter to the correct range and polarity before connecting to the circuit.
9A2	<p>Understand that voltmeters have a high internal resistance so that they draw minimal current from the circuit under test.</p> <p>Understand that ammeters have a low internal resistance so that they minimise the voltage loss to the circuit under test.</p> <p>Understand that a voltmeter is always connected in parallel with a component or circuit being tested.</p> <p>Understand that an ammeter is always connected in series with a component or circuit being tested.</p>
9A3	Understand the advantages and disadvantages of analogue and digital displays and be able to read analogue and digital values.
9A5	Understand the use of voltmeters and ammeters to determine the power applied to a circuit.

	Decibels
9B1	<p>Recall that decibels are a power ratio.</p> <p>Recall that a power gain of 3 dB equates to doubling the power and 10dB equates to a power increase of times 10.</p> <p>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.</p> <p>Recall that dB gains and losses in a system can be added to find the total gain or loss in the system.</p> <p>Recall the meaning of:</p> <ul style="list-style-type: none"> • dBW (comparison with 1 W) • dBi (comparison with an isotropic radiator) and • dBd (comparison with a half wave dipole).
	Components
9C1	<p>Recall the resistor colour code, colours 0 to 9 with gold as multiplier.</p> <p>Recall silver (10%) and gold (5%) as tolerance bands.</p> <p>Identify the value of a resistor between 1 Ω and 9M Ω from the E12 series.</p> <p>Recall how to read both 4 band and 5 band resistors.</p> <p>Recall how to read components with a numeric marking of the format 4R7, 3k3 or for capacitors, 103.</p> <p><i>Note: The resistor colour code will be provided and actual encoding or decoding of colours will be either 4 band or 5 band resistors.</i></p> <p><i>Candidates are not expected to know the values of the E12 series.</i></p>
	Construction
9D1	<p>Recall that screening with thin metal sheet is effective in reducing unwanted radiation from equipment and/or between stages within equipment.</p>
	Soldering
9E1	<p>Understand that soldering is a method of joining metal wires and components using solder and a hot soldering iron.</p>
9E2	<p>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.</p>
9E3	<p>Recall that some metals are easier to solder than others.</p>
9E4	<p>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.</p> <p>Recall the reason for tinning wires prior to soldering.</p>

Note: See combined syllabus for the Introduction and Examination Material parts of the specification.