Matt & Brian's

STOLEN SLIDE GUIDE

General class license

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TABLE OF CONTENTS

Introduction

Subelement G1: Commission's Rules (5 groups, 5 exam questions)............................7

- G1A - General class control operator frequency privileges; primary and secondary allocations
- G1B - Antenna structure limitations; good engineering and good amateur practice; beacon operation; restricted operation; retransmitting radio signals
- G1C - Transmitter power regulations; HF data emission standards
- G1D - Volunteer Examiners and Volunteer Examiner Coordinators; temporary identification
- G1E - Control categories; repeater regulations; harmful interference; third party rules; ITU regions

Subelement G2: OPERATING PROCEDURES (6 groups, 6 exam questions)........14

- G2A - Phone operating procedures; USB/LSB utilization conventions; procedural signals; breaking into a QSO in progress; VOX operation
- G2B - Operating courtesy; band plans
- G2C - Emergencies, including drills and emergency communications
- G2D - Amateur auxiliary; minimizing interference; HF operations
- G2E - Digital operating: procedures, procedural signals and common abbreviations
- G2F - CW operating procedures and procedural signals, Q signals and common abbreviations; full break in

Subelement G3: Radio Wave Propagation (3 groups, 3 exam questions)..................21

- G3A - Sunspots and solar radiation; ionospheric disturbances; propagation forecasting and indices
- G3B - Maximum Usable Frequency; Lowest Usable Frequency; propagation "hops"
- G3C - Ionospheric layers; critical angle and frequency; HF scatter; Near Vertical Incidence Sky waves

Subelement G4: Amateur Radio Practices (5 groups, 5 exam questions)................25

- G4A - Two-tone Test; amplifier tuning and neutralization; DSP
- G4B - Test and monitoring equipment
- G4C - Interference with consumer electronics; grounding
- G4D - Speech processors; S meters; common connectors
- G4E - HF mobile radio installations; emergency and battery powered operation

Subelement G5: Electrical Principles (3 groups, 3 exam questions)............................7

- G5A - Resistance; reactance; inductance; capacitance; impedance; impedance matching
- G5B - The Decibel; current and voltage dividers; electrical power calculations; sine wave root-mean-square (RMS) values; PEP calculations
- G5C: Resistors, capacitors, and inductors in series and parallel; transformers

Subelement G6: Circuit Components (3 groups, 3 exam questions).........................32

- G6A - Resistors; capacitors; inductors
- G6B - Rectifiers; solid state diodes and transistors; solar cells; vacuum tubes; batteries
- G6C - Analog and digital integrated circuits (ICs); microprocessors; memory; I/O devices; microwave ICs (MMICs); display devices

Subelement G7: Practical Circuits (2 groups, 2 exam questions)...............................36

- G7A - Power supplies; transmitters and receivers; filters, schematic drawing symbols
- G7B - Digital circuits (gates, flip-flops, shift registers); amplifiers and oscillators

Subelement G8: Signals and Emissions (2 groups, 2 exam questions)........................45

- G8A - Carriers and modulation: AM; FM; single and double sideband; modulation envelope; deviation; overmodulation
- G8B - Frequency mixing; multiplication; HF data communications; bandwidths of various modes

Subelement G9: Antennas and Feedlines (4 groups, 4 exam questions)....................47

- G9A - Antenna feedlines: characteristic impedance, and attenuation; SWR calculation, measurement and effects; matching networks
- G9B - Basic antennas
- G9C - Directional antennas
- G9D - Specialized antennas

Subelement G0: Electrical and RF Safety (2 groups, 2 exam questions)....................51

- G0A - RF safety principles, rules and guidelines; routine station evaluation
- G0B - Safety in the ham shack: electrical shock and treatment, grounding, fusing, interlocks, wiring, antenna and tower safety

Subelement G1

Commission's Rules (5 groups, 5 exam questions)

G1A - General class control operator frequency privileges; primary and secondary allocations

When you get your General Class license you will have many more frequencies to use than when you were a Technician. On **160, 30, 17, 12, and 10 meters,** a General Class license holder is granted all amateur frequency privileges. **24.940 MHz** is in the 12 meter band.

On other bands, however, there are restrictions**.**For example, phone operation prohibited on **30 meters**. Image transmission is also prohibited on **30 meters**. **60 meters** is the amateur band that restricts communication to specific channels, using only USB voice, and prohibits all other modes, including CW and data.

When a General Class licensee is not permitted to use the entire voice portion of a particular band, **the upper end** of the voice segment is generally available to them. Here are some examples:

- **7.250 MHz** is in the General Class portion of the 40 meter band.
- **3900 kHz** is within the General class portion of the 75 meter phone band.
- **14305 kHz** is within the General Class portion of the 20 meter phone band.
- **21300 kHz** is within the General Class portion of the 15 meter band.

When a General Class licensee is not permitted to use the entire voice portion of a particular band, it is usually the lowest 25 kHz of a band that is not available to him or her. For example, 3520 kHz would not be available, but **3560 kHz** is within the General Class portion of the 80 meter band.

All of these answers are correct when talking about frequencies available to a control operator holding a General Class license: 28.020 MHz, 28.350 MHz, 28.550 MHz.

Some amateur radio bands are shared with other services. Be aware, however that **none** of the amateur band are shared with the Citizens Radio Service.

When the FCC rules designate the amateur service as a secondary user and another service as a primary user on a band, **amateur stations are allowed to use the frequency band only if they do not cause harmful interference to primary users**. For example, when operating on either the 30 or 60 meter bands, a station in the primary service interferes with your contact, you must **stop transmitting at once and/or move to a clear frequency**. Amateur radio stations are a secondary service in the 60 meter band, and **they must not cause harmful interference to stations operating in other radio services**.

G1B - Antenna structure limitations; good engineering and good amateur practice; beacon operation; restricted operation; retransmitting radio signals

In addition to the regulations regarding frequencies that you can use, there are a whole raft of regulations that determine what you can and cannot do. For example, you may wish to build a tower for your antenna system. If you do so, you must be aware that **200 feet** is the maximum height above ground to which an antenna structure may be erected without requiring notification to the FAA and registration with the FCC, provided it is not at or near a public-use airport.

You may also want to set up a beacon station. **Observation of propagation and reception, or other related activities** is a purpose of a beacon station as identified in the FCC Rules. One of the conditions with which beacon stations must comply is that **there must be no more than one beacon signal in the same band from a single location**. The power limit for beacon stations is **100 watts PEP output**.

You must also never use secret codes. The use of abbreviations or procedural signals in the amateur service are restricted, but **they may be used if they do not obscure the meaning of a message**. The only time an amateur station permitted to transmit secret codes is **to control a space station**.

Before an amateur station may provide news information to the media during a disaster, **the information must directly relate to the immediate safety of human life or protection of property and there is no other means of communication available**.

The only time music be transmitted by an amateur station is **when it is an incidental part of a space shuttle or ISS retransmission**.

All of these answers are correct when referring to transmissions prohibited by the FCC Rules for amateur radio stations:

- Transmission of music as the primary program material during a contact
- The use of obscene or indecent words
- Transmission of false or deceptive messages or signals

An amateur station may transmit communications in which the licensee or control operator has a pecuniary (monetary) interest **only when other amateurs are being notified of the sale of apparatus normally used in an amateur station and such activity is not done on a regular basis**.

For operations not explicitly covered by the Part 97 rules, the FCC requires an amateur station be operated **in conformance with good engineering and good amateur practice**. **The FCC** determines what "good engineering and good amateur practice" means as they apply to the operation of an amateur station. If an amateur station is causing interference to a broadcast receiver of good engineering design, the FCC may **restrict the amateur station op-**

eration to times other than 8 pm to 10:30 pm local time every day, as well as on Sundays from 10:30 am to 1 pm local time.

G1C - Transmitter power regulations; HF data emission standards

In general, 1500 watts PEP is the absolute maximum amount of power that amateur radio stations can use when transmitting. Other than the 1500 watt PEP limit, the only other restriction placed on transmitter power in the 14 MHz band (and all other bands for that matter) is that **only the minimum power necessary to carry out the desired communications should be used**.

1500 watts PEP output is the maximum transmitting power an amateur station may use on the 12 meter band. **1500 watts PEP output** is the maximum transmitting power a General class licensee may use when operating between 7025 and 7125 kHz. **1500 watts PEP output** is the maximum transmitting power a station with a General Class control operator may use on the 28 MHz band. **1500 watts PEP output** is the maximum transmitting power an amateur station may use on 1825 kHz.

On 30m and 60m, the power limit is much lower. **200 watts PEP output** is the maximum transmitting power an amateur station may use on 10.140 MHz. When a station is transmitting on the 60 meter band, **transmissions must not exceed an effective radiated power of 50 Watts PEP referred to a dipole antenna**.

There are also restrictions on how fast you can send digital data. For example, **300 baud** is the maximum symbol rate permitted for RTTY emissions transmitted on frequency bands below 28 MHz. **1200 baud** is the maximum symbol rate permitted for RTTY or data emission on the 10m band. **19.6 kilobaud** is the maximum symbol rate permitted for RTTY or data emission transmissions on the 6 and 2 meter bands. **19.6 kilobaud** is the maximum symbol rate permitted for packet emission transmissions on the 2 meter band.

There are also some bandwidth limitations that you need to know. **20 kHz** is the maximum authorized bandwidth for RTTY, data or multiplexed emissions using an unspecified digital code transmitted on the 6 and 2 meter bands. **2.8 kHz** is the maximum bandwidth permitted by FCC rules for amateur radio stations when operating on USB frequencies in the 60-meter band.

G1D - Volunteer Examiners and Volunteer Examiner Coordinators; temporary identification

Amateur radio license examinations are given by amateur radio operators who have volunteered to perform this service and have been accredited to do so. They are called volunteer examiners (VEs), and volunteer examiners are accredited by **a Volunteer Examiner Coordinator**. To gain accreditation, VEs must meet several requirements.

For example, to be accredited, **the person must hold a U.S. amateur radio license of General class or above**. You may participate as a VE in administering an amateur radio license examination **once you have been granted your General class license and received your VEC accreditation**. **18 years** is the minimum age that one must be to qualify as an accredited Volunteer Examiner. A non U.S. citizen may be an accredited Volunteer Examiner.

When you are an accredited VE holding a General Class operator license, you may only administer the **Technician** license examination. **A FCC General class or higher license and VEC accreditation** is sufficient for you to be an administering VE for a Technician Class operator license examination. **At Least three VEC-accredited General Class or higher VEs must be present** for administering a Technician Class operator examination.

The administering VEs are responsible at a Volunteer Exam Session for determining the correctness of the answers on the exam. VEs must issue a **CSCE** document to a person that passes an exam element. A Certificate of Successful Completion of Examination (CSCE) is valid for exam element credit for **365 days** after successfully completed that exam element.

If you are a Technician Class operator and have a CSCE for General Class privileges, you may operate **on any General Class band segment**. You do, however, have to identify in a special way until your upgrade appears in the FCC ULS database. The proper way to identify when transmitting on General class frequencies if you have a CSCE for the required elements but your upgrade from Technician has not appeared in the ULS database is to **give your call sign followed by the words "temporary AG."**

You must add the special identifier "AG" after your call sign if you are a Technician Class licensee and have a CSCE for General Class operator privileges **whenever you operate using General class frequency privileges**. Whenever you operate on frequencies allocated to Technician Class licensees, you do not have to use the special identifier.

G1E - Control categories; repeater regulations; harmful interference; third party rules; ITU regions

A **repeater station** is the kind of amateur station simultaneously retransmits the signals of other stations on another channel. Some repeaters are cross-band repeaters. That is, they receive a signal on one band and repeat it on another. When this happens, it is important to know the license class of the control operator. A 10 meter repeater may retransmit the 2 meter signal from a station having a Technician Class control operator **only if the 10 meter control operator holds at least a General class license**.

Because repeater stations may cover a wide area, it is necessary to coordinate their input and output frequencies to avoid interference. The power to assign frequencies has been given to coordinating bodies in particular regions. A repeater station may operate on frequencies that have not been assigned to it, but will have to cease operation if it causes any interference. **The licensee of the non-coordinated repeater has primary responsibility to resolve the interference** in the event of interference between a coordinated repeater and an uncoordinated repeater.

Third-party traffic has always been a hot topic for radio amateurs. Third-party traffic is any message sent by someone who is not an amateur radio operator over an amateur radio link. **Only messages relating to amateur radio or remarks of a personal character, or messages relating to emergencies or disaster relief** may be transmitted by an amateur station for a third party in another country. If **the third party is a person previously licensed in the amateur service whose license had been revoked**, that party is disqualified from participating in stating a message over an amateur station.

Third-party traffic is prohibited with **any country other than the United States, unless there is a third-party agreement in effect with that country**, except for messages directly involving emergencies or disaster relief communications. For a non-licensed person to communicate with a foreign amateur radio station from a US amateur station at which a licensed control operator is present, **the foreign amateur station must be in a country with which the United States has a third party agreement. Sending a message to a third party through a foreign station** is a permissible third party communication during routine amateur radio operations **as long as that person is a licensed amateur radio operator**.

Another cardinal rule of amateur radio is to never willfully cause interference to other amateur radio operators or other services. **All of these answers are correct** when considering which of the following conditions require an amateur radio station to take specific steps to avoid harmful interference to other users or facilities:

- When operating within one mile of an FCC Monitoring Station
- When using a band where the amateur service is secondary
- When a station is transmitting spread spectrum emissions

It is also important to properly identify your station. You must use **English** when identifying your station if you are using a language other than English in making a contact.

Subelement G2

Operating Procedures (6 groups, 6 exam questions)

G2A - Phone operating procedures; USB/LSB utilization conventions; procedural signals; breaking into a QSO in progress; VOX operation

SSB is the mode of voice communication most commonly used on the High Frequency Amateur bands. Single sideband (SSB) i**s a form of amplitude modulation in which one sideband and the carrier are suppressed**. When using the single sideband (SSB) voice mode, **only one sideband is transmitted; the other sideband and carrier are suppressed**. When compared to other voice modes on the HF amateur bands, using single sideband is an advantage because of **less bandwidth used and high power efficiency**.

Lower Sideband is the sideband most commonly used on the 160, 75, and 40 meter bands. The reason most amateur stations use lower sideband on the 160, 75 and 40 meter bands is because it is **current amateur practice is to use lower sideband on these frequency bands**.

Upper Sideband is the sideband most commonly used for phone communications on the bands above 20 meters. **Upper Sideband is the** sideband most commonly used in the VHF and UHF bands. **Upper Sideband** is the mode most commonly used for voice communications on the 17 and 12 meter bands.

VOX is short for voice-operated transmission. **VOX allows "hands free" operation. All of these choices are correct** when talking about user adjustable controls that are usually associated with VOX circuitry:

- Anti-VOX
- VOX Delay
- VOX Sensitivity

Here are a couple of operating procedures to keep in mind when operating phone. The recommended way to break into a conversation when using phone is to **say your call sign during a break between transmissions from the other stations**. When an operator uses the expression "CQ DX," it usually indicates that **the caller is looking for any station outside their own country**. If you are in the same country as the calling station, do not answer this call.

G2B - Operating courtesy; band plans

The amateur radio bands are often congested. To make this situation as pleasant as possible, please be courteous to other operators. This will help minimize interference.

A practical way to avoid harmful interference when selecting a frequency to call CQ using phone is to **ask if the frequency is in use, say your callsign, and listen for a response**. A practical way to avoid harmful interference when calling CQ using Morse code or CW is to **send "QRL? de" followed by your callsign and listen for a response**.

Another way to be courteous is to keep enough space between your transmissions and transmissions of other amateurs. **Approximately 3 kHz** is the minimum frequency separation between SSB signals should be allowed to minimize interference. **150 to 500 Hz** is the minimum frequency separation between CW signals should be allowed to minimize interference. **250 to 500 Hz** is the minimum frequency separation between 170 Hz shift RTTY signals should be allowed to minimize interference. If you notice increasing interference from other activity on a frequency you are using, **move your contact to another frequency**.

Many amateurs like to meet on a single frequency. This is called a "net." If a net is about to begin on a frequency you and another station are using, **move to a different frequency as a courtesy to the net**. If the frequency on which a net normally meets is in use just before the net begins, **ask the stations if the net may use the frequency, or move the net to a nearby clear frequency if necessary.**

Another way amateurs attempt to minimize interference is by publishing band plans. A band plan is **a voluntary guideline for band use beyond the divisions established by the FCC**. In order to comply with good amateur practice when choosing a frequency for Slow-Scan TV (SSTV) operation, **follow generally accepted band plans for SSTV operation**. In order to comply with good amateur practice when choosing a frequency for radio-teletype RTTY) operation, **follow generally accepted band plans for RTTY operation**. In order to comply with good amateur practice when choosing a frequency for HF PSK operation, **follow generally accepted band plans for PSK operation**. The "DX window" in a voluntary band plan is **a portion of the band that should not be used for contacts between stations within the 48 contiguous United States**.

G2C - Emergencies, including drills and emergency communications

One of the purposes of amateur radio is to aid emergency communications. The first thing you should do if you are communicating with another amateur station and hear a station in distress break in is to **acknowledge the station in distress and determine what assistance may be needed. The location and nature of the emergency** should be given to a station answering a distress transmission.

An amateur station is **never** prevented from using any means at its disposal to assist another station in distress. When normal communications systems are not available, an amateur station may use **any means of radiocommunication at its disposal** to provide essential communications when there is an immediate threat to the safety of human life or the protection of property.

You are never prohibited from helping any station in distress from helping a station in distress. **Whatever frequency has the best chance of communicating the distress message** is the frequency should be used to send a distress call. An amateur station may make **transmissions necessary to meet essential communications needs and to facilitate relief actions** during a disaster. **Any mode** can be used to obtain assistance during a disaster. **Any frequency authorized to the control operator** may be used by an amateur station to obtain assistance when in distress.

When helping out in an emergency or making a distress call, always be sure to identify your station properly. A control operator is making **an unidentified transmission** when transmitting out of the amateur band without station identification during a life threatening emergency.

RACES stands for Radio Amateur Civil Emergency Service. When operating RACES events, certain restrictions apply. **Only a person holding an FCC issued amateur operator license** may be the control operator of an amateur station transmitting in RACES to assist relief operations during a disaster. The FCC may restrict normal frequency operations of amateur stations participating in RACES **when the President's War Emergency Powers have been invoked.**

G2D - Amateur auxiliary; minimizing interference; HF operations

The Amateur Auxiliary are **amateur volunteers who are formally enlisted to monitor the airwaves for rules violations**. The objectives of the Amateur Auxiliary are **to encourage amateur self-regulation and compliance with the rules**. Amateurs in the Amateur Auxiliary hone their skills to help them in their job. For example, many take part in "fox hunts," in which they attempt to find a low-power transmitter. During "Fox Hunts," Amateur Auxiliary members learn **direction-finding skills used to locate stations violating FCC Rules**.

An azimuthal projection map is **a world map projection centered on a particular location**. An **azimuthal projection** map is the most useful type of map to use when orienting a directional HF antenna toward a distant station. When making a "long-path" contact with another station, a directional antenna is pointed **180 degrees from its short-path heading.**

While it is not necessary to log contacts, there are some records that you must keep. For example, a licensee must retain as part of their station records **antenna gain calculations or manufacturer's data for antennas used on 60 meters**. FCC rules require, when operating in the 60 meter band, that, **if you are using other than a dipole antenna, you must keep a record of the gain of your antenna**.

Many amateurs will, however, keep a log even though the FCC doesn't require it. One reason to do so is **to help with a reply if the FCC requests information on who was control operator of your station at a given date and time**. **All of these choices are correct** when discussing what information is traditionally contained in a station log:

- Date and time of contact
- Band and/or frequency of the contact
- Call sign of station contacted and the signal report given

One aspect of the hobby that has become quite popular is QRP operation. QRP operation is **low power transmit operation, typically about 5 watts**. One of the reasons for its popularity is that low-power operation can substantially minimize the interference you cause.

There are other ways to minimize interference, such as your choice of antennas. **A unidirectional antenna** would be the best HF antenna to use for minimizing interference.

G2E - Digital operating: procedures, procedural signals and common abbreviations

Now that computers are widely used in amateur radio, digital modes, such as RTTY, have become quite popular. The abbreviation "RTTY" stands for **Radio-Teletype**.

You need to know how to set up your equipment to use them properly. For example, you should select the **LSB** mode when using a SSB transmitter with an Audio Frequency Shift Keying (AFSK) RTTY signal. **170 Hz** is the most common frequency shift for RTTY emissions in the amateur HF bands.

Messages sent via RTTY most often use the Baudot code. The Baudot code is a **5-bit code, with additional start and stop bits**.

PSK31 is also a very popular mode because it allows you to communicate with low power even in adverse conditions. One of the reasons for this is that **the number** of data bits **varies** in a single PSK31 character.

PSK31 is only one of a number of recently-developed digital modes. Another is MFSK16. The abbreviation "MFSK" stands for **Multi (or Multiple) Frequency Shift Keying**. A major advantage of MFSK16 compared to other digital modes is that **it offers good performance in weak signal environment without error correction**.

Stations using packet radio communicate in much the same way that computer communicate over the internet. Stations decompose a message into "packets" of data which are sent out over the air and are then re-assembled at the receiving station. Because the message may pass through several relay stations, the packets contain routing and handling information so that they get sent to the appropriate receiving station. The part of a data packet contains the routing and handling information is called the **header**.

Digital communications can take place on the VHF bands or the HF bands. The 20 meter band segment most often used for most data is **14.070 - 14.100 MHz**. On the 20 meter band, PSK signals generally found **around 14.070 MHz**. **3570 - 3600 kHz** is the segment of the 80 meter band is most commonly used for data transmissions.

G2F - CW operating procedures and procedural signals, Q signals and common abbreviations; full break in

Even though a Morse Code test is no longer required to obtain a General Class license, it remains a popular mode. There are a number of things to keep in mind when making CW contacts. These considerations will make operating CW much for fun for all operators.

CW operators pride themselves on the courtesy they show to other operators. For example, it is courteous not to send faster than the other station is capable of receiving. With that in mind, the best speed to use answering a CQ in Morse Code is **the speed at which the CQ was sent**. It is also courteous to slow down when requested to do so. **Send slower** if a CW station sends "QRS" when using Morse code.

To help ensure that a station you are calling can hear you, you should try to transmit on a frequency as close to the other station's frequency as possible. We say that you should "zero beat" the other station. In CW operation, the term "zero beat" means **matching the frequency of the transmitting station**.

In a CW contact, one of the first things sent is a signal report, often called an RST report. It consists of three numbers denoting: readability (1-5), strength (1-9), and tone (1-9). When a "C" is added to the RST report, it means that the sending station has a **chirpy or unstable signal**.

Amateur operators in contact using CW have a form of shorthand, called Q-signals, that they use to reduce the number of characters they must send. Q-signals are three-letter signals all beginning with the letter "Q." For example, the Q signal "QSL" means "**I acknowledge receipt**." The Q signal "QRQ" means "**send faster**." The Q signal "QRV" means "**I am ready to receive messages**."

When using Morse code, operators also use a variety of "prosigns," which are meant to inform other operators of certain things. For example, when a CW operator sends "KN" at the end of a transmission, it means that he or she is **listening only for a specific station or stations**. When a CW operator sends "CL" at the end of a transmission, it means **closing station**, or in other words, going off the air. **AR** is the prosign sent to indicate the end of a formal message.

A station is operating with full break-in telegraphy (QSK) when **incoming signals are received between transmitted code character elements**.

Subelement G3

Radio Wave Propagation (3 groups, 3 exam questions)

G3A - Sunspots and solar radiation; ionospheric disturbances; propagation forecasting and indices

Amateur radio communications is subject to the whims of nature. Many different phenomena affect amateur radio communications, and it behooves us to know a little something about the phenomena. Doing so, will make you a more effective amateur radio communicator.

The phenomenon that most affects amateur radio communication is the sunspot cycle. The typical sunspot cycle is **approximately 11 years**. The sunspot number is **a measure of solar activity based on counting sunspots and sunspot groups**. **Long-distance communication in the upper HF and lower VHF range is enhanced** when sunspot numbers are high.

The sunspot cycle is a long-term phenomenon. There are other phenomenon which are short-term that also deserve consideration. For example, the solar flux index is a measure of **the radio energy emitted by the sun**. In particular, it is the **measure of solar activity at 10.7 cm**. The K-index is **a measure of the short term stability of the Earth's magnetic field**. The A-index is **an indicator of the long term stability of the Earth's geomagnetic field**.

At any point in the solar cycle, the 20 meter band usually supports worldwide propagation during daylight hours. **Frequencies above 20 MHz** are the frequencies are least reliable for long distance communications during periods of low solar activity. If the HF radio-wave propagation (skip) is generally good on the 24-MHz and 28-MHz bands for several days, you might expect a similar condition to occur **28 days later**.

A Sudden Ionospheric Disturbance (SID) will have an effect on the daytime ionospheric propagation of HF radio waves. In particular, **it disrupts signals on lower frequencies more than those on higher frequencies**. To continue communications during a sudden ionospheric disturbance **try a higher frequency**.

During an SID , the sun emits a great deal of ultraviolet and X-ray radiation. The increased ultraviolet and X-ray radiation from solar flares takes **approximately 8 minutes** to affect radio-wave propagation on the Earth.

Also, **HF communications are disturbed** by the charged particles that reach the Earth from solar coronal holes. It takes **20 to 40 hours** for charged particles from Coronal Mass Ejections to affect radio-wave propagation on the Earth.

Geomagnetic disturbances also cause disruptions in HF propagation. A geomagnetic disturbance is **a significant change in the Earth's magnetic field over a short period of**

time. Latitudes **greater than 45 degrees North or South latitude** have propagation paths that are more sensitive to geomagnetic disturbances. **Degraded high-latitude HF propagation** is an effect of a geomagnetic storm on radio-wave propagation.

One possible benefit to radio communications resulting from periods of high geomagnetic activity is an **aurora that can reflect VHF signals**.

G3B - Maximum Usable Frequency; Lowest Usable Frequency; propagation "hops"

The two most important parameters for predicting the propagation between two locations are the MUF and LUF. MUF stands for the **Maximum Usable Frequency for communications between two points**. LUF stand for the **Lowest Usable Frequency for communications between two points**.

Radio waves with frequencies below the maximum usable frequency (MUF) **are bent back to the Earth** when they are sent into the ionosphere. Radio waves with frequencies below the lowest usable frequency (LUF) **are completely absorbed by the ionosphere**. When the lowest usable frequency (LUF) exceeds the maximum usable frequency (MUF), **no HF radio frequency will support communications over the path**.

Select a frequency just below the MUF is the guideline that one should use when deciding on a frequency that will give the lowest attenuation when transmitting on HF. For example, **15 meters** is the band should offer the best chance for a successful contact if the maximum usable frequency (MUF) between the two stations is 22 MHz. **20 meters** is the band that should offer the best chance for a successful contact if the maximum usable frequency (MUF) between the two stations is 16 MHz.

How do you determine the MUF? Well, one reliable way to determine if the maximum usable frequency (MUF) is high enough to support 28-MHz propagation between your station and Western Europe is to **listen for signals on a 28 MHz international beacon**. **All of these choices are correct** when talking about factors that affect the maximum usable frequency (MUF):

- Path distance and location
- Time of day and season
- Solar radiation and ionospheric disturbance

2,500 miles is the maximum distance along the Earth's surface that is normally covered in one hop using the F2 region. **1,200 miles** the maximum distance along the Earth's surface that is normally covered in one hop using the E region.

If a sky-wave signal sound arrives at your receiver by both short path and long path propagation, **a well-defined echo can be heard**.
Sometimes you can use conditions on one band to predict propagation conditions on another band. For example, **short hop sky-wave propagation on the 10 meter band** is a good indicator of the possibility of sky-wave propagation on the 6 meter band.

G3C - Ionospheric layers; critical angle and frequency; HF scatter; Near Vertical Incidence Sky waves

The D layer is the ionospheric layer closest to the surface of the Earth. **The D layer** is the ionospheric layer is the most absorbent of long skip signals during daylight hours on frequencies below 10 MHz. Long distance communication on the 40, 60, 80 and 160 meter bands more difficult during the day because **the D layer absorbs these frequencies during daylight hours**. **Absorption will be minimum** near the maximum usable frequency (MUF).

The F2 region can be expected to reach its maximum height at your location **at noon during the summer**.The F2 region mainly responsible for the longest distance radio wave propagation **because it is the highest ionospheric region**.

The term 'critical angle,' as used in radio wave propagation, means **the highest takeoff angle that will return a radio wave to the Earth under specific ionospheric conditions**.

Scatter propagation is a phenomenon often observed when using the HF bands. **Scatter** radio wave propagation allows a signal to be detected at a distance too far for ground wave propagation but too near for normal sky wave propagation. An indication that signals heard on the HF bands are being received via scatter propagation is when **the signal is heard on a frequency above the maximum usable frequency**.

A characteristic of HF scatter signals is that **they have a wavering sound**. HF scatter signals often sound distorted because **energy is scattered into the skip zone through several radio wave paths**. HF scatter signals in the skip zone are usually weak because **only a small part of the signal energy is scattered into the skip zone**.

Short distance HF propagation using high elevation angles is called Near Vertical Incidence Sky-wave (NVIS) propagation. **A horizontal dipole placed between 1/8 and 1/4 wavelength above the ground** is the type of antenna that will be most effective for skip communications on 40 meters during the day.

Subelement G4

Amateur Radio Practices (5 groups, 5 exam questions)

G4A - Two-tone Test; amplifier tuning and neutralization; DSP

Digital signal processing (DSP) is a common feature of modern amateur radio transceivers. DSP filtering is accomplished **by converting the signal from analog to digital and using digital processing**. **All of the these answers are correct** when talking about what is needed for a DSP IF filter:

- An Analog to Digital Converter
- Digital to Analog Converter
- A Digital Processor Chip

An advantage of a receiver IF filter created with a DSP as compared to an analog filter is that **a wide range of filter bandwidths and shapes can be created**. One use for a DSP in an amateur station is **to remove noise from received signals**. **A DSP filter** performs automatic notching of interfering carriers.

A two-tone test analyzes a transmitter's **linearity**. **Two non-harmonically related audio signals** are used to conduct a two-tone test. **An oscilloscope** is an instrument that may be used to measure the output of a single sideband transmitter when performing a two-tone test of amplitude linearity.

When using a linear amplifier that uses vacuum tubes, pay special attention to tuning procedures. **A pronounced dip** on the plate current meter of a vacuum tube RF power amplifier indicates correct adjustment of the plate tuning control. The correct adjustment for the "Load" or "Coupling" control of a vacuum tube RF power amplifier is **maximum power output without exceeding maximum allowable plate current**.

Negative feedback is used to neutralize an RF amplifier. The reason for neutralizing the final amplifier stage of a transmitter is **to eliminate self oscillations**. A neutralizing circuit in an RF amplifier **cancels the effects of positive feedback**.

G4B - Test and monitoring equipment

When you set up your amateur radio station, sometimes called your "shack," you'll not only want to acquire radios, but also some test equipment. The most basic piece of test equipment is the voltmeter. Voltmeters may be either analog or digital.

Significantly better precision for most uses is an advantage of a digital voltmeter as compared to an analog voltmeter. Digital voltmeters usually have higher input impedances than analog meters. High input impedance is desirable for a voltmeter because **it decreases the loading on circuits being measured**.

An oscilloscope is another handy piece of test equipment to have in your shack. With an oscilloscope, you can view waveforms of signals. An advantage of an oscilloscope versus a digital voltmeter is that **complex waveforms can be measured**. **An oscilloscope** is an item of test equipment contains horizontal and vertical channel amplifiers.

A monitoring oscilloscope is the best instrument to use to check the keying waveform of a CW transmitter. **The attenuated RF output of the transmitter** is the signal source connected to the vertical input of a monitoring oscilloscope when checking the quality of a transmitted signal.

Sometimes when troubleshooting, you need a signal source to provide an input for a circuit. To troubleshoot receiver circuits, you might want to use a signal tracer. You would normally use a signal tracer **to identify an inoperative stage in a receiver**.

A noise bridge is a device that you can use to measure the impedance of an antenna system. **Pre-tuning an antenna tuner** is one way a noise bridge might be used. When someone uses a noise bridge, **it is connected between a receiver and an antenna of unknown impedance and is adjusted for minimum noise**.

A similar piece of test equipment is the antenna analyzer. One advantage that an antenna analyzer has over a noise bridge is that it can measure SWR directly. An **antenna and feedline** must be connected to an antenna analyzer when it is being used for SWR measurements.

Another instrument that is sometimes used to measure the resonant frequency of an antenna is the dip meter. Determining **the resonant frequency of a circuit** is one measurement that can be made with a dip meter.

A field-strength meter is an instrument that may be used to monitor relative RF output when making antenna and transmitter adjustments. **The radiation pattern** of an antenna can be determined with a field strength meter. **Close-in radio direction-finding** is another use for a field strength meter.

For measuring the output power of your transmitter, you would use a wattmeter. **Standing Wave Ratio** (SWR) can be measured with a directional wattmeter. This is done by making two measurements—the power being sent to the antenna and the power reflected by the antenna—and then calculating the SWR.

Nearly all commercial receivers have an “S” meter to indicate relative signal strength. Each digit on an S-meter corresponds to an increase or decrease of about 6 dB. This means that power output of a transmitter must be raised **approximately 4 times** to change the "S" meter reading on a distant receiver from S8 to S9.

G4C - Interference with consumer electronics; grounding

At some point or another, your amateur radio station will interfere with a radio, television set, or telephone. Sometimes this may be your fault, other times it may be the fault of the device. In either case, you should do everything you can to eliminate this interference.

Public-address (PA) systems are often the targets of interference. **Distorted speech** is the sound is heard from a public-address system if there is interference from a nearby single-sideband phone transmitter. **On-and-off humming or clicking** is the effect on a public-address system if there is interference from nearby CW transmitter.

There are many things that you can do. For example, a **bypass capacitor** might be useful in reducing RF interference to audio-frequency devices. One reason to place ferrite beads around audio cables to reduce common mode RF interference is that **they act as a series inductor**. **An RFI filter at the affected telephone** should be installed if a properly operating amateur station is interfering with a nearby telephone.

One of the most basic things you can do to eliminate interference is to ensure that your station is properly grounded. **All of these answers are correct** when considering important reasons to have a good station ground:

- To reduce the likelihood of RF burns
- To reduce the likelihood of electrical shock
- To reduce interference

A good practice is to keep the wire from your equipment to the ground rod as short as possible. One good way to avoid stray RF energy in an amateur station is to **keep the station's ground wire as short as possible**.

Keeping the ground wire short will prevent the wire from being resonant on a frequency that you are likely to operate. When the ground wire is resonant, it may actually present a high impedance to the RF energy, making it relatively useless as a ground. It might be that **the ground wire is resonant** if you receive an RF burn when touching your equipment while transmitting on a HF band, assuming the equipment is connected to a ground rod. **RF hot spots can occur in a station located above the ground floor if the equipment is grounded by a long ground wire**.

When grounding your station, make sure that all conductors make good electrical contact. **Induced currents in conductors that are in poor electrical contact** can cause unintended rectification of RF signal energy and can result in interference to your station as well as nearby radio and TV receivers. **Arcing at a poor electrical connection** is one cause of broadband radio frequency interference at an amateur radio station. **Connect all ground conductors to a single point** to avoid a ground loop.

While grounding equipment, you should also consider electrical safety. **Electrical safety inside the ham shack** is one topic covered in the National Electrical Code.

G4D - Speech processors; S meters; common connectors

Speech processors can be very useful when operating SSB. The reason for using a properly adjusted speech processor with a single sideband phone transmitter is that **it improves signal intelligibility at the receiver**. **It increases the average power** of a transmitted single sideband signal.

When using a speech compressor, it is important to adjust it properly. **All of these answers are correct** when talking about the result of using an incorrectly adjusted speech processor:

- Distorted speech
- Splatter
- Excessive background pickup

On the receive side, a useful device is the S-meter. An S-meter measures **received signal strength**. An S-meter generally found **in a receiver**.

The S-meter use s a logarithmic scale, with each S-unit 6 dB greater than the previous one, assuming a properly calibrated S meter. A signal with an S-meter reading of 20 db over S-9 **is 100 times stronger** than an S-9 signal, assuming a properly calibrated S meter.

In amateur radio, you will use many different types of connectors. A **UHF** connector is commonly used for RF service at frequencies up to 150 MHz. A Type-N connector is **a moisture resistant RF connector useful to 10 GHz**. A **DB-9** would be a good choice for a serial data port connector. An **RCA Phono** connector is commonly used for audio signals in amateur radio stations.

Some connectors are keyed, while others are not. The main reason to use keyed connectors over non-keyed types is the **reduced chance of damage due to incorrect mating**.

G4E - HF mobile radio installations; emergency and battery powered operation

Operating mobile, that is from a car or boat, is an activity enjoyed by many radio amateurs. And amateurs can do almost everything from a mobile station that they can do at a fixed station. **All of these choices are correct** when discussing transmission types that are permissible while operating HF mobile:

- CW
- SSB
- FM

When setting up your mobile station, it is important to consider how you are going to supply power to your radios. **A direct, fused connection to the battery using heavy gauge wire** is the best power connection for a 100-watt HF mobile installation. One reason that it is best NOT to draw the DC power for a 100-watt HF transceiver from an automobile's cigarette lighter socket is that **the socket's wiring may be inadequate for the current being drawn by the transceiver**.

A commonly encountered problem when operating from an automobile with alternator whine. Alternator whine is **a tone or buzz in transmitted or received audio that varies with engine speed**.

As you can imagine, mobile antennas are always a compromise. **The HF mobile antenna system** is the factor that most limits the effectiveness of an HF mobile transceiver operating in the 75 meter band.

For providing emergency power, amateurs will often use a gasoline-powered generator. **The generator should be located in a well ventilated area** in an emergency generator installation. **Danger of carbon monoxide poisoning** is a primary reason for not placing a gasoline-fueled generator inside an occupied area. It would be unwise to power your station by back feeding the output of a gasoline generator into your house wiring by connecting the generator through an AC wall outlet because **it might present a hazard for electric company workers**.

Some amateurs use photovoltaic cells to provide emergency power. **Photovoltaic conversion** is the name of the process by which sunlight is changed directly into electricity. **0.5 VDC** is the approximate open-circuit voltage from a modern, well illuminated photovoltaic cell. **Doped Silicon** is a material used as the active element of a solar cell.

Some amateurs use solar cells to charge batteries. You must be careful when using lead-acid batteries in this application. A lead-acid storage battery might give off explosive hydrogen gas **when being charged**.

Finally, some amateurs even use wind power as an emergency power source. A disadvantage to using wind power as the primary source of power for an emergency station is that **a large**

energy storage system is needed to supply power when the wind is not blowing.

Subelement G5

Electrical Principles (3 groups, 3 exam questions)

G5A - Resistance; reactance; inductance; capacitance; impedance; impedance matching

Reactance is the **opposition to the flow of alternating current caused by capacitance or inductance**. **Reactance** causes opposition to the flow of alternating current in an inductor. **Reactance** causes opposition to the flow of alternating current in a capacitor. The **Ohm** is the unit used to measure reactance.

A coil reacts to AC in this way: **as the frequency of the applied AC increases, the reactance increases**. A capacitor reacts to AC in the opposite way. **As the frequency of the applied AC increases, the reactance decreases**.

Impedance is **the opposition to the flow of current in an AC circuit**. It is the combination of the capacitive reactance, the inductive reactance, and the resistance in a circuit. The **Ohm** is also used to measure impedance.

The source can deliver maximum power to the load when the impedance of an electrical load is equal to the internal impedance of the power source. Impedance matching is important **so the source can deliver maximum power to the load**.

To maximize the transfer of power, use an impedance matching transformer. Core saturation of a conventional impedance matching transformer should be avoided because **harmonics and distortion could result**.

One method of impedance matching between two AC circuits is to **insert an LC network between the two circuits**. **All of these choices are correct** devices when talking about devices that can be used for impedance matching at radio frequencies:

- A transformer
- A Pi-network
- A length of transmission line

G5B - The Decibel; current and voltage dividers; electrical power calculations; sine wave root-mean-square (RMS) values; PEP calculations

The RMS value is the measurement of an AC signal that is equivalent to a DC voltage of the same value. For an AC signal with a sine wave shape, the RMS value is .707 times the peak value. **12 volts** is the RMS voltage of sine wave with a value of 17 volts peak.

Conversely, the peak-to-peak value is twice the peak value, or 2 x 1.414 x the RMS value. Accordingly, **339.4 volts** is the peak-to-peak voltage of a sine wave that has an RMS voltage of 120 volts.

The square root of the average of the sum of the squares of each voltage waveform would be the RMS voltage if you combined two or more sine wave voltages.

Power is equal to the RMS voltage times the current, or

$$P \text{ (watts)} = V_{RMS} \times I$$

Using Ohm's Law, we can show that:

$$P = V^2_{RMS} / R$$

$$P = I^2 \times R$$

Using these formulas, you can see that **200 watts** of electrical power are used if 400 VDC is supplied to an 800-ohm load. **2.4 watts** of electrical power are used by a 12-VDC light bulb that draws 0.2 amperes. **Approximately 61 milliwatts** are being dissipated when a current of 7.0 milliamperes flows through 1.25 kilohms.

These formulas can also be used to calculate RF power and RF voltages and currents. **245 volts** would be the voltage across a 50-ohm dummy load dissipating 1200 watts.

A term sometimes used in phone work is peak envelope power (PEP). This is the maximum instantaneous power achieved when transmitting a phone signal. Since the amplitude of a phone signal varies with time, the average power may be considerably less. **1060 watts** is the output PEP of an unmodulated carrier if an average reading wattmeter connected to the transmitter output indicates 1060 watts. **1.00** is the ratio of peak envelope power to average power for an unmodulated carrier.

The output PEP from a transmitter is **100 watts** if an oscilloscope measures 200 volts peak-to-peak across a 50-ohm dummy load connected to the transmitter output. **625 watts** is the output PEP from a transmitter if an oscilloscope measures 500 volts peak-to-peak across a 50-ohm resistor connected to the transmitter output.

Often, we're not concerned with the actual power, but with the ratio of power input to power output. For example, if an amplifier has a gain of 10, we know that if we input a 1 W signal, we'll get 10 W out. Quite often, you'll see this ratio specified in decibels, or dB.

The formula for calculating power ratios in dB is:

$$A(dB) = 10 \times \log_{10}(P2/P1)$$

Using this formula, you can see that a two-times increase or decrease in power results in a change of **3 dB**. By rearranging the terms of this equation, you would calculate that **20.5 %** is the percentage of power loss would that result from a transmission line loss of 1 dB.

The total current **equals the sum of the currents through each branch** of a parallel circuit.

G5C: Resistors, capacitors, and inductors in series and parallel; transformers

Connecting components in series and in parallel will affect their effective values. For example, if you connect resistors in series, the effective resistance is the sum of the individual resistances. **A resistor in series** should be added to an existing resistor in a circuit to increase circuit resistance.

Connecting resistors in parallel will decrease the circuit resistance. For example, the total resistance of three 100-ohm resistors in parallel is **33.3 ohms**. **5.9 ohms** is the total resistance of a 10 ohm, a 20 ohm, and a 50 ohm resistor in parallel. **150 ohms** is the value of each resistor, which when three of them are connected in parallel produce 50 ohms of resistance, and the same three resistors in series produce 450 ohms.

Inductors work the same way. **An inductor in series** should be added to an inductor in a circuit to increase the circuit inductance. The inductance of a 20 millihenry inductor in series with a 50 millihenry inductor is **70 millihenrys**, but the inductance of three 10 millihenry inductors connected in parallel is **3.3 millihenrys**.

Capacitors, however, are quite the opposite. **A capacitor in parallel** should be added to a capacitor in a circuit to increase the circuit capacitance, while connecting capacitors in series will decrease circuit capacitance. The capacitance of a 20 microfarad capacitor in series with a 50 microfarad capacitor is **14.3 microfarads**. The capacitance of three 100 microfarad capacitors connected in series **33.3 microfarads**. The equivalent capacitance of two 5000 picofarad capacitors and one 750 picofarad capacitor connected in parallel is **10750 picofarads**.

Inductors exhibit a behavior called mutual inductance. Mutual inductance occurs when a current flowing through one inductor induces a current in a nearby inductor. We use this behavior to create components called transformers.

The simplest transformer has two windings: a primary winding and a secondary winding. The source of energy is normally connected **to the primary winding** in a transformer. **Mutual inductance** causes a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding.

The voltage across the secondary winding will be equal to the ratio of the number of turns in the secondary to the number of turns in the primary. For example, the voltage across a 500-turn secondary winding of a transformer is **26.7 volts** if the 2250-turn primary is connected to 120 VA.

Transformers are also used to transform impedances. The impedance ratio is also related to the turns ratio. The turns ratio of a transformer used to match an audio amplifier having a 600-ohm output impedance to a speaker having a 4-ohm impedance is **12.2 to 1**.

Transformers are not 100% efficient. That is, they will draw current and consume power even when no load is attached to the secondary winding. The current in the primary winding of a transformer when no load is attached to the secondary is called **magnetizing current.**

Subelement G6
Circuit Components (3 groups, 3 exam questions)

G6A - Resistors; capacitors; inductors

There are a number of practical considerations you must make when using electronic components in circuits. For example, the resistance of a carbon resistor **will change depending on the resistor's temperature coefficient rating** if the temperature is increased. In some cases, we can use this characteristic to our advantage. For example, A thermistor is **a device having a controlled change in resistance with temperature variations**.

One type of resistor that's commonly used is the wire-wound resistor. Its main advantage is that its value can bet set very precisely. The main disadvantage of using a conventional wire-wound resistor in a resonant circuit is that **the resistor's inductance could detune the circuit** that it is used in.

It's also important to choose capacitors wisely. For example, **comparatively low cost** is the primary advantage of ceramic capacitors, but they may have a high temperature coefficient.

High capacitance for given volume is an advantage of an electrolytic capacitor. For this reason, an **electrolytic** capacitor is often used in power-supply circuits to filter the rectified AC.

The leads of a capacitor are inductive, and at some frequencies, this is significant. One effect of lead inductance in a capacitor used at VHF and above is that the **effective capacitance may be reduced**.

A popular choice for inductors is the ferrite core inductor. **All of these choices are correct** when talking about the advantages of using a ferrite core with a toroidal inductor:

- Large values of inductance may be obtained
- The magnetic properties of the core may be optimized for a specific range of frequencies
- Most of the magnetic field is contained in the core

As noted earlier, placing two inductors closely together may cause unwanted mutual inductance. One reason why it might be important to minimize the mutual inductance between two inductors is **to reduce or eliminate unwanted coupling.** Two solenoid inductors should be placed **with their winding axes at right angles to each another** so as to minimize their mutual inductance.

Another unwanted characteristic of inductors is the capacitance between windings of the inductor. One effect of inter-turn capacitance in an inductor is that **the inductor may become self resonant at some frequencies**.

Many times, components are made with specific characteristics for particular applications. For example, **suppressor capacitor i**s the common name for a capacitor connected across a transformer secondary that is used to absorb transient voltage spikes. **Filter choke** is the common name for an inductor used to help smooth the DC output from the rectifier in a conventional power supply.

G6B - Rectifiers; solid state diodes and transistors; solar cells; vacuum tubes; batteries

The diode is one of the most versatile components. They are used to rectify AC voltages, regulate DC voltages, switch RF voltages, and demodulate radio signals. One of the most important parameters of a diode used for rectification is the peak inverse voltage (PIV). The peak-inverse-voltage rating of a rectifier is **the maximum voltage the rectifier will handle in the non-conducting direction**.

The two major ratings that must not be exceeded for silicon-diode rectifiers are **peak inverse voltage; average forward current**. Average forward current is the maximum amount of current that the diode can handle when it is forward biased and conducting. If the average forward current is greater than this value, there is a good chance that the diode will "burn out."

Another important diode parameter is the junction threshold voltage. This voltage will be different for different types of diodes. The approximate junction threshold voltage of a germanium diode is **0.3 volts**. The approximate junction threshold voltage of a silicon diode is **0.7 volts**. Like resistors, you can connect two or more diodes in parallel to increase the current handling capacity. When doing so, connect a small resistor in parallel with each of the diodes. When two or more diodes are connected in parallel to increase current handling capacity, the purpose of the resistor connected in series with each diode is so that **the resistors ensure that one diode doesn't carry most of the current**.

A type of diode often used in RF circuits is the Schottky diode. **Lower capacitance** is an advantage of using a Schottky diode in an RF switching circuit as compared to a standard silicon diode. The lower capacitance allows it to switch faster than other types of diodes.

There are two main types of transistors, bipolar transistors and field effect transistors (FETs). **An FET** is the solid state device most like a vacuum tube in its general characteristics. The following describes the construction of a MOSFET: **the gate is separated from the channel with a thin insulating layer**.

Transistors are often used in amateur radio circuits as amplifiers and switches. The stable operating points for a bipolar transistor that is used as a switch in a logic circuit are **its saturation and cut-off regions**. When used as an amplifier or a power supply pass transistor, it is often necessary to insulate the case of a large power transistor **to avoid shorting the collector or drain voltage to ground**.

Some amateur radio equipment, most notably linear amplifiers, still uses vacuum tubes. The simplest vacuum is the triode, which has three elements: the cathode, the control grid, and the plate. The **control grid** is the element of a triode vacuum tube is used to regulate the flow of electrons between cathode and plate.

A pentode is a tube with five elements, one of which is called the screen grid. The primary purpose of a screen grid in a vacuum tube is **to reduce grid-to-plate capacitance**.

Batteries are often used to power amateur radio equipment, so it's important to know their characteristics and how to use them. Some batteries can be used only once, while others are rechargeable. For example, **Nickel Metal Hydride** is a type of rechargeable battery, but it is **never** acceptable to recharge a carbon-zinc primary cell.

Nickel Cadmium batteries, sometimes called "Ni-Cads," are another type of rechargeable battery. **High discharge current** is an advantage of the low internal resistance of Nickel Cadmium batteries.

For applications that require long battery life, 12 volt lead acid batteries, often car batteries or deep cycle marine batteries are used. When using these batteries, it's important to not discharge them all the way. **10.5 volts** is the minimum allowable discharge voltage for maximum life of a standard 12 volt lead acid battery.

G6C - Analog and digital integrated circuits (ICs); microprocessors; memory; I/O devices; microwave ICs (MMICs); display devices

Most amateur radio devices today contain integrated circuits (ICs). On a single piece of silicon, manufacturers can put thousands of transistors, implementing very complex circuit functions. ICs may contain analog circuits, digital circuits, or a combination of both. A simple example is the **linear voltage regulator**, which is most often provided as an analog integrated circuit. Another commonly used **analog** IC is an operational amplifier.

A more sophisticated analog IC is the MMIC. The term MMIC means **Monolithlic Microwave Integrated Circuit.**

Digital ICs are often described by the technology used to create the transistors. One type, or "family," of digital IC uses complementary, metal-oxide semiconductor, or CMOS, transistors. **CMOS** is the most commonly used digital logic family of integrated circuits.
CMOS has several advantages over other IC technologies, such as transistor-transistor logic (TTL). **Low power consumption**, for example, is an advantage of CMOS Logic integrated circuits compared to TTL logic circuits.

Memories are an important type of digital IC. The term ROM refers to **Read Only Memory**, which is a type of memory often used to store microprocessor programs. ROM is "non-volatile," meaning **the stored information is maintained even if power is removed.**

ROMS are often used to store programs that run microprocessors. A microprocessor is **a miniature computer on a single integrated circuit chip**. Modern amateur radio transceivers usually have one or more microprocessors to control their operation.

These transceivers use light-emitting diodes (LEDs) or liquid crystal displays (LCDs) to display operating status, such as frequency. An LED is **forward biased** when emitting light. Older radios often used incandescent bulbs instead of LEDs. **High power consumption** is one disadvantage of an incandescent indicator compared to a LED.

LCDs do not emit light. Therefore, one characteristic of a liquid crystal display is that **it requires ambient or back lighting**.

Most modern transceivers can now be controlled by a computer. A common way to connect a computer to a transceiver is with a USB interface. A **computer and transceiver** are two devices in an amateur radio station that might be connected using a USB interface.

Subelement G7

Practical Circuits (2 groups, 2 exam questions)

G7A - Power supplies; transmitters and receivers; filters, schematic drawing symbols

Power supplies are devices that convert AC power to the DC voltages needed to power amateur radio equipment. There are two main types of power supplies available: linear power supplies and switching power supplies.

Linear supplies use a transformer to transform the voltage up or down, a rectifier to convert the AC voltage to a DC voltage, and capacitors and inductors to smooth the output voltage. The rectifier in a linear supply may be a half-wave rectifier, a full-wave rectifier, or bridge rectifier.

180 degrees is the portion of the AC cycle is converted to DC by a half-wave rectifier. **360** degrees portion of the AC cycle is converted to DC by a full-wave rectifier. **A series of DC pulses at twice the frequency of the AC input** is the output waveform of an unfiltered full-wave rectifier connected to a resistive load.

The minimum peak-inverse-voltage rating of the rectifier in a full-wave power supply is **double the normal peak output voltage of the power supply**. The approximate minimum peak-inverse-voltage rating of the rectifier in a half-wave power supply is **two times the normal peak output voltage of the power supply**.

The output of a rectifier connects to a filter made up of capacitors and inductors. **Capacitors and inductors** are used in a power-supply filter network. **Low equivalent series resistance** is a desirable characteristic for capacitors used to filter the DC output of a switching power supply.

A safety feature found on many linear power supplies is the bleeder resistor. **It discharges the filter capacitors** once the power supply is turned off.

Switching, or switched-mode power supplies are now being sold by many vendors. One advantage of a switched-mode power supply as compared to a linear power supply is that **high frequency operation allows the use of smaller components**. One disadvantage is that the circuits are much more complex than linear power supply circuits.

Filters are an important part of amateur radio equipment. For example, a filter might be used to process signals from the balanced modulator and send them to the mixer in a single-sideband phone transmitter.

You might also use a filter, called a low-pass filter because it's designed to pass all frequencies below a "cutoff frequency," to avoid causing interference to nearby television sets. You connect the low-pass filter between your transceiver and your antenna. The impedance of a low-pass filter as compared to the impedance of the transmission line into which it is inserted should be **about the same**.

Balanced modulators is a type of circuit found in amateur radio transmitters. A **balanced modulator** is used to combine signals from the carrier oscillator and speech amplifier and send the result to the filter in a typical single-sideband phone transmitter. Most amateur radio transmitters use variable frequency oscillators to set the output frequency, but some still use the fixed-frequency crystal oscillator. **Stable output frequency** is an advantage of a crystal controlled transmitter.

The superheterodyne receiver is the most popular type of amateur radio receiver. Superheterodyne receivers convert the received frequency to an intermediate frequency (IF) and then process that IF signal. A **mixer** is used to process signals from the RF amplifier and local oscillator and send the result to the IF filter in a superheterodyne receiver. A **product detector is** used to process signals from the IF amplifier and BFO and send the result to the AF amplifier in a single-sideband phone superheterodyne receiver. The combination of an **HF oscillator, mixer,** and **detector** is the simplest combination of stages that can be combined to implement a superheterodyne receiver.

Another type of receiver is the direct conversion receiver. **A direct conversion receiver** is a type of receiver suitable for CW and SSB reception but does not require a mixer stage or an IF amplifier. While simpler, direct conversion receivers often do not perform as well as superheterodyne receivers.

The **discriminator** is a type of circuit is used in many FM receivers to convert signals coming from the IF amplifier to audio.

When designing or troubleshooting radios, amateur radio operators use schematic diagrams to describe circuits. Various symbols represent the different types of components. A typical schematic is shown in Figure G7-1.

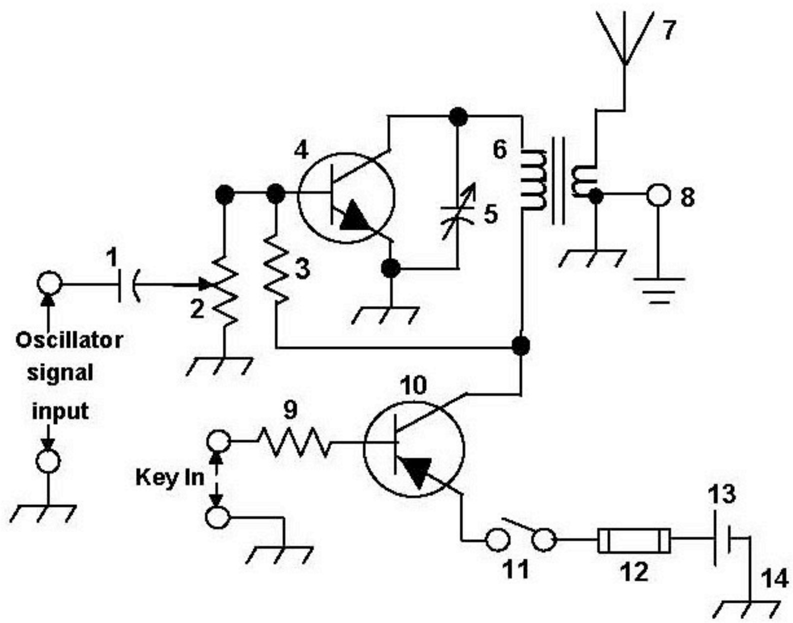


Figure G7-1. Common Schematic Symbols

Symbol 3 symbol in figure G7-1 represents a fixed resistor.
Symbol 13 in figure G7-1 represents a single cell battery.
Symbol 4 in figure G7-1 represents a NPN transistor.
Symbol 5 in figure G7-1 represents a variable capacitor.
Symbol 6 in figure G7-1 represents a transformer.
Symbol 11 in figure G7-1 represents a single pole switch.

G7B - Digital circuits (gates, flip-flops, shift registers); amplifiers and oscillators

Digital circuits are circuits whose outputs are one of two voltages - either "on" or "off" or "one" or "zero." Digital circuits use the binary number system because **binary "ones" and "zeros" are easy to represent with an "on" or "off" state**.

We use digital circuits to implement logic functions, and there are many integrated circuits that implement specific logic functions, such as the NAND function or NOR function. **Zero** is the output of a two-input NAND gate, given both inputs are "one." **One** is the output of a NOR gate given that both inputs are "zero."

More complex logic functions, such as flip-flops, counters, and shift registers, are also available. A "flip-flop" circuit **a digital circuit with two stable states**. There are **8** states are in a 3-bit binary counter. A shift register is **a clocked array of circuits that passes data in steps along the array**.

An oscillator is a circuit that generates an AC signal output. **A filter and an amplifier operating in a feedback loop** are the basic components of virtually all oscillators.
Some oscillators use and RC circuit for feedback. **The phase shift of the RC feedback circuit** determines the frequency of an RC oscillator. Other oscillators use and LC circuit for feedback. **The inductance and capacitance in the tank circuit** determines the frequency of an LC oscillator.

There are many different types of amplifiers. A linear amplifier, sometimes called a Class A amplifier, is **an amplifier whose output preserves the input waveform**. **Low distortion** is a characteristic of a Class A amplifier.

The Class C amplifier is not linear. An advantage of a Class C amplifier **high efficiency**. **CW** is the mode for which a Class C power stage is appropriate. To determine the efficiency of an RF power amplifier, **divide the RF output power by the DC input power**.

Subelement G8
Signals and Emissions (2 groups, 2 exam questions)

G8A - Carriers and modulation: AM; FM; single and double sideband; modulation envelope; deviation; overmodulation

Amplitude modulation is the name of the process that changes the envelope of an RF wave to convey information. **Amplitude modulation** is the type of transmission that varies the instantaneous power level of the RF signal to convey information.

Single sideband, or SSB, is a type of amplitude modulation (AM). A conventional AM signal has three components, the carrier and two sidebands. An SSB transmitter uses a balanced modulator to eliminate the carrier signal. **Both upper and lower sidebands** signal(s) would be found at the output of a properly adjusted balanced modulator. A filter is then used to eliminate one of the sidebands.

One advantage of carrier suppression in a single-sideband phone transmission is that **more transmitter power can be put into the remaining sidebands**. Another advantage is that **single sideband** phone emissions use the narrowest frequency bandwidth.

You must be careful when setting the audio level used to modulate a phone signal. If you set the level too high, the signal will be over-modulated, and an over-modulated single-sideband phone transmitter signal **becomes distorted and occupies more bandwidth**. This distortion is sometimes called flat-topping. Flat-topping of a single-sideband phone transmission is **signal distortion caused by excessive drive.**

To set the appropriate level, you use the radio's ALC meter. The **audio or microphone gain** is the control typically adjusted for proper ALC setting on an amateur single sideband transceiver.

Frequency modulation is the name of the process which changes the frequency of an RF wave to convey information. When a modulating audio signal is applied to an FM transmitter, **the carrier frequency changes proportionally to the instantaneous amplitude of the modulating signal**.

Phase modulation is the name of the process that changes the phase angle of an RF wave to convey information. **Phase modulation** is also the type of emission produced by a reactance modulator connected to an RF power amplifier.

G8B - Frequency mixing; multiplication; HF data communications; bandwidths of various modes

One of the most important circuits found in amateur radio equipment is the mixer. A mixer takes two input signals and outputs the sum and difference of the two input signals. **Heterodyning** is another term for the mixing of two RF signals.

The **mixer** is the receiver stage that combines a 14.250 MHz input signal with a 13.795 MHz oscillator signal to produce a 455 kHz intermediate frequency (IF) signal. If a receiver mixes a 13.800 MHz VFO with a 14.255 MHz received signal to produce a 455 kHz intermediate frequency (IF) signal, a 13.345 MHz signal produce will produce an unwanted **image response** in the receiver.

Mixers are also used in transmitters. **A mixer** in a transmitter would change a 5.3 MHz input signal to 14.3 MHz.

FM transmitters use multipliers to produce the VHF signal. The **multiplier** is the name of the stage in a VHF FM transmitter that selects a harmonic of an HF signal to reach the desired operating frequency.

On the VHF bands, we frequency use frequency-modulated (FM) phone. Two important parameters of an FM signal are bandwidth and deviation. Frequency modulated (FM) phone is not used below 29.5 MHz because **the bandwidth would exceed FCC limits**. The total bandwidth of an FM-phone transmission having a 5 kHz deviation and a 3 kHz modulating frequency is **16 kHz**. **416.7 Hz** is the frequency deviation for a 12.21-MHz reactance-modulated oscillator in a 5-kHz deviation, 146.52-MHz FM-phone transmitter.

Digital modes are now quite popular. RTTY, Morse code, PSK31 and packet communications **are digital modes**. An RTTY signal shifts between two set frequencies. This is sometimes called frequency-shift keying, or FSK. In an FSK signal, frequency shift is related to keying speed. In particular, **greater keying speeds require greater frequency shifts.** When transmitting a digital, or data mode, it is important to know the duty cycle of the mode you are using **to prevent damage to your transmitter's final output stage**.

The part of the 20 meter band most commonly used for PSK31 operation is **below the RTTY segment, near 14.070 MHz**.

Subelement G9

Antennas and Feedlines (4 groups, 4 exam questions)

G9A - Antenna feedlines: characteristic impedance, and attenuation; SWR calculation, measurement and effects; matching networks

Feedlines are the cables used to connect antennas to receivers and transmitters. Perhaps the most important characteristic of a feedline is its characteristic impedance. **50 and 75 ohms** are the typical characteristic impedance of coaxial cables used for antenna feedlines at amateur stations. **300 ohms** is the characteristic impedance of flat ribbon TV type twin lead. **The distance between the centers of the conductors and the radius of the conductors** are factors that determine the characteristic impedance of a parallel conductor antenna feedline.

A difference between feedline impedance and antenna feed point impedance is a common reason for the occurrence of reflected power at the point where a feedline connects to an antenna. A measure of this mismatch is the standing-wave-ratio, or SWR. The SWR is the ratio of the impedances.

A standing-wave-ratio of **4:1** will result from the connection of a 50-ohm feed line to a non-reactive load having a 200-ohm impedance. A standing-wave-ratio of **5:1** will result from the connection of a 50-ohm feed line to a non-reactive load having a 10-ohm impedance. A standing-wave-ratio of **1:1** will result from the connection of a 50-ohm feed line to a non-reactive load having a 50-ohm impedance.

The SWR will be **2:1** if you feed a vertical antenna that has a 25-ohm feed-point impedance with 50-ohm coaxial cable. The SWR will be **6:1** if you feed a folded dipole antenna that has a 300-ohm feedpoint impedance with 50-ohm coaxial cable. If the SWR on an antenna feedline is 5 to 1, and a matching network at the transmitter end of the feedline is adjusted to 1 to 1 SWR, the resulting SWR on the feedline will be **5 to 1**.

To prevent standing waves on an antenna feedline, **the antenna feed point impedance must be matched to the characteristic impedance of the feedline**. One reason for using an inductively coupled matching network between the transmitter and parallel conductor feed line feeding an antenna is **to match the unbalanced transmitter output to the balanced parallel conductor feedline**.

The attenuation of coaxial cable **increases** as the frequency of the signal it is carrying increases. RF feed line losses are usually expressed in **dB per 100 ft**.

G9B - Basic antennas

There are many different types of antennas, including:

- random-wire antennas,
- dipole antennas, and
- vertical antennas - including ground-plane antennas.

One disadvantage of a directly fed random-wire antenna is that **you may experience RF burns when touching metal objects in your station**.

A vertical antenna is quarter wavelength long and operates against ground or a set of radials. The radial wires of a ground-mounted vertical antenna system should be placed **on the surface or buried a few inches below the ground**.

When mounted above ground, the vertical antenna is often called a ground-plane antenna. The natural feedpoint impedance of the ground-plane antenna is 35 ohms, but the feed-point impedance of a ground-plane antenna **increases** when its radials are changed from horizontal to downward-sloping. An advantage of downward sloping radials on a ground-plane antenna is that **they can be adjusted to bring the feed-point impedance closer to 50 ohms**.

The half-wavelength dipole antenna is perhaps the most common amateur radio antenna. The approximate length for a 1/2-wave dipole antenna cut for 14.250 MHz is **32.8 feet**. The approximate length for a 1/2-wave dipole antenna cut for 3.550 MHz is **131.8 feet**. The approximate length for a 1/4-wave vertical antenna cut for 28.5 MHz is **8.2 feet**.

The low angle azimuthal radiation pattern of an ideal half-wavelength dipole antenna **is a figure-eight at right angles to the antenna** when installed 1/2 wavelength high and parallel to the earth. **If the antenna is less than 1/2 wavelength high, the azimuthal pattern is almost omnidirectional.**

As the antenna is lowered from 1/4 wave above ground, the feed-point impedance of a 1/2 wave dipole antenna **steadily decreases**. As the feed-point location is moved from the center toward the ends, the feed-point impedance of a 1/2 wave dipole **steadily increases**.

Vertical antennas are vertically polarized, while dipole antennas are usually horizontally polarized. An advantage of a horizontally polarized as compared to vertically polarized HF antenna is **lower ground reflection losses**.

G9C - Directional antennas

To make their signals more effective, some amateurs use directional antennas. These antennas direct a transmitted signal in a particular direction and are more sensitive to signals coming from that direction.

The Yagi antenna is one type of directional antenna. One reason a Yagi antenna is often used for radio communications on the 20 meter band is that **it helps reduce interference from other stations to the side or behind the antenna**.

The Yagi antenna consists of a driven element, a reflector, and possibly one or more directors. The approximate length of the driven element of a Yagi antenna is **1/2 wavelength**.

A Yagi antenna consists of a driven element and some combination of parasitically excited reflector and/or director elements. A three-element Yagi would consist of one driven element, one reflector, and one director. The reflector is generally about 5% longer than the driven element, while the director is about 5% shorter. **The director is normally the shortest parasitic element**. **The reflector is normally the longest parasitic element.**

The "front-to-back ratio" of a Yagi antenna is **the power radiated in the major radiation lobe compared to the power radiated in exactly the opposite direction**. The approximate maximum theoretical forward gain of a 3 Element Yagi antenna is 9.7 dBi. The "main lobe" of a directive antenna is **the direction of maximum radiated field strength from the antenna**.

The purpose of a "gamma match" used with Yagi antennas is **to match the relatively low feed-point impedance to 50 ohms**. **No insulation in needed** when connecting the driven element of a Yagi antenna from the metal boom when using a gamma match.

By changing the characteristics of the elements you can change the characteristics of the antenna. **Use larger diameter elements** to increase the SWR bandwidth of a Yagi antenna. As you increase the boom length and adding directors to a Yagi antenna, **gain increases**. **All of these choices are correct** when talking about Yagi antenna design variables that could be adjusted to optimize forward gain, front-to-back ratio, or SWR bandwidth:

- the physical length of the boom,
- the number of elements on the boom, and
- the spacing of each element along the boom.

Cubical quads are another type of directional antenna. **A cubical quad antenna** is typically constructed from 2 square loops of wire each having a circumference of approximately one wavelength at the operating frequency and separated by approximately 0.2 wavelength. Each side of a cubical-quad antenna driven element is approximately **1/4 wavelength**. The forward gain of a 2-element cubical-quad antenna is **about the same** as the forward gain of a 3 element Yagi antenna. Each side of a cubical-quad antenna reflector element is **slightly more than 1/4 wavelength**.

The gain of a two element delta-loop beam is **about the same** as the gain of a two element cubical quad antenna. Each leg of a symmetrical delta-loop antenna driven element is approximately **1/3 wavelengths**.

The polarization of the radiated signal changes from vertical to horizontal when the feed-point of a cubical quad antenna is changed from the center of the lowest horizontal wire to the center of one of the vertical wires.

The reflector element must be approximately 5% longer than the driven element in a cubical-quad antenna must be used for the antenna to operate as a beam antenna, assuming one of the elements is used as a reflector.

G9D - Specialized antennas

The term "NVIS" means **near vertical incidence skywave** when talking about antennas. An NVIS antenna typically installed **between 1/10 and 1/4 wavelength** above ground. **High vertical angle radiation for short skip during the day** is an advantage of an NVIS antenna.

While a Yagi antenna is a great antenna, you can improve the performance of this antenna by stacking one on top of another. The gain of two 3-element horizontally polarized Yagi antennas spaced vertically 1/2 wave apart from each another is **approximately 3 dB higher** than the gain of a single 3-element Yagi. Vertical stacking of horizontally polarized Yagi antennas **narrows the main lobe in elevation**.

Another type of antenna sometimes used in amateur radio is the log periodic antenna. **Length and spacing of elements increases logarithmically from one end of the boom to the other** describes a log periodic antenna. **Wide bandwidth** is an advantage of a log periodic antenna.

A Beverage antenna generally not used for transmitting because **it has high losses compared to other types of antennas**. An application for a Beverage antenna is **directional receiving for low HF bands.** A Beverage antenna is **a very long and low receiving antenna that is highly directional**.

Many antennas are designed for a single band, but in many cases, putting up an antenna for each band you want to operate is impractical. So, many amateurs put up antennas that will work on more than one band. These are called multiband antennas. One disadvantage of multiband antennas is that **they have poor harmonic rejection**.

One type of multiband antenna is the trap vertical. The primary purpose of traps installed in antennas is **to permit multiband operation**.

Subelement G0

Electrical and RF Safety (2 groups, 2 exam questions)

G0A - RF safety principles, rules and guidelines; routine station evaluation

If you learn nothing else from this manual, I hope you'll learn to be safe when indulging in amateur radio. The first topic that we'll cover is RF safety.

One way that RF energy can affect human body tissue is that **it heats body tissue**. The effects take place over time. "Time averaging," in reference to RF radiation exposure, means **the total RF exposure averaged over a certain time**. This also means that when evaluating RF exposure **a lower transmitter duty cycle permits greater short-term exposure levels**.

The power level and frequency of the energy have the most direct effect on the permitted exposure level of RF radiation. **A calibrated field-strength meter with a calibrated antenna** can be used to accurately measure an RF field. One property that is NOT important in estimating if an RF signal exceeds the maximum permissible exposure (MPE) is **its critical angle**.

An amateur operator must **perform a routine RF exposure evaluation** to ensure compliance with RF safety regulations. **All of these choices are correct** when trying to determine if your station complies with FCC RF exposure regulations:

- by calculation based on FCC OET Bulletin 65,
- by calculation based on computer modeling, and
- by measurement of field strength using calibrated equipment.

If an evaluation of your station shows RF energy radiated from your station exceeds permissible limits, you must **take action to prevent human exposure to the excessive RF fields**. **No further action is required** when the maximum power output capability of an otherwise compliant station is reduced.

The amount of exposure depends greatly on the positioning of an antenna. For example, you should **make sure that MPE limits are not exceeded in occupied areas** if you install an indoor transmitting antenna. When installing a ground-mounted antenna, **it should be installed so no one can be exposed to RF radiation in excess of maximum permissible limits**. Whenever you make adjustments or repairs to an antenna, **turn off the transmitter and disconnect the feedline**.

An RF evaluation should take into account not only your house and property, but also your neighbors. One thing that can be done if evaluation shows that a neighbor might receive more than the allowable limit of RF exposure from the main lobe of a directional antenna is **take precautions to ensure that the antenna cannot be pointed at their house**.

Some repeater stations may be located at a site with multiple transmitters. **Any transmitter that contributes 5% or more of the MPE** at a multiple user site is responsible for RF safety compliance.

G0B - Safety in the ham shack: electrical shock and treatment, grounding, fusing, interlocks, wiring, antenna and tower safety

When playing around with any radio gear, remember that electricity can be a dangerous thing. **60 cycle Alternating current** is the most hazardous type of electrical energy. **Current through the heart can cause the heart to stop pumping**. This is the mechanism by which electrical shock can be lethal. **50 microamperes** is the maximum amount of electrical current flow through the human body that can be tolerated safely.

When wiring a "shack," pay special attention to the currents that the circuits will supply and use fuses with the appropriate ratings the appropriate wire sizes. For example, **15 amperes** is the size of fuse or circuit breaker would be appropriate to use with a circuit that uses AWG number 14 wiring. **AWG number 12** is the minimum wire size that may be safely used for a circuit that draws up to 20 amperes of continuous current.

For some devices, such as linear ampllifiers, you may have to install a 240 VAC line. Remember, **only the "hot" (black and red) wires** wire(s) in a four-conductor line cord should be attached to fuses or circuit breakers in a device operated from a 240-VAC single-phase source. You can make your shack safer by using Ground Fault Circuit Interrupters (GFCIs). **Current flowing from the hot wire to ground** will cause a Ground Fault Circuit Interrupter (GFCI) to disconnect the 120 or 240 Volt AC line power to a device.

Another way to make the shack safer is to have the proper grounds. The metal chassis of every item of station equipment must be grounded (assuming the item has such a chassis) because **it ensures that hazardous voltages cannot appear on the chassis**.

It is also helpful if your equipment has safety features. For example, the purpose of a transmitter power supply interlock is **to ensure that dangerous voltages are removed if the cabinet is opened**.

Another hazard is the antenna tower. Any person preparing to climb a tower that supports electrically powered devices should **make sure all circuits that supply power to the tower are locked out and tagged**. Also, when climbing on a tower using a safety belt or harness, **always attach the belt safety hook to the belt "D" ring with the hook opening away from the tower.**

Because they can be hit by lightning, towers must be properly grounded. One good engineering practice for lightning protection grounds is that **they must be bonded together with all other grounds**. It is not safe to use soldered joints with the wires that connect the base of a tower to a system of ground rods because **a soldered joint will likely be destroyed by the heat of a lightning strike**.

Finally, be careful if you use lead-tin solder. One danger of using lead-tin solder is that **lead can contaminate food if hands are not washed carefully after handling**.

General Class License Examination Question Pool - Element 3		
Sub	**Title**	**Sections**
G1	COMMISSION'S RULES	G1A - General class control operator frequency privileges; primary and secondary allocations G1B - Antenna structure limitations; good engineering and good amateur practice; beacon operation; restricted operation; retransmitting radio signals G1C - Transmitter power regulations; HF data emission standards G1D - Volunteer Examiners and Volunteer Examiner Coordinators; temporary identification G1E - Control categories; repeater regulations; harmful interference; third party rules; ITU regions
G2	OPERATING PROCEDURES	G2A - Phone operating procedures; USB/LSB utilization conventions; procedural signals; breaking into a QSO in progress; VOX operation G2B - Operating courtesy; band plans G2C - Emergencies, including drills and emergency communications G2D - Amateur auxiliary; minimizing Interference; HF operations G2E - Digital operating: procedures, procedural signals and common abbreviations G2F - CW operating procedures and procedural signals, Q signals and common abbreviations; full break in
G3	RADIO WAVE PROPAGATION	G3A - Sunspots and solar radiation; ionospheric disturbances; propagation forecasting and indices G3B - Maximum Usable Frequency; Lowest Usable Frequency; propagation "hops" G3C - Ionospheric layers; critical angle and frequency; HF scatter; Near Vertical Incidence Sky waves
G4	AMATEUR RADIO PRACTICES	G4A - Two-tone Test; amplifier tuning and neutralization; DSP G4B - Test and monitoring equipment G4C - Interference with consumer electronics; grounding G4D - Speech processors; S meters; common connectors G4E - HF mobile radio installations; emergency and battery powered operation
G5	ELECTRICAL PRINCIPLES	G5A - Resistance; reactance; inductance; capacitance; impedance; impedance matching G5B - The Decibel; current and voltage dividers; electrical power calculations; sine wave root-mean-square (RMS) values; PEP calculations G5C - Resistors, capacitors, and inductors in series and parallel; transformers
G6	CIRCUIT COMPONENTS	G6A - Resistors; capacitors; inductors G6B - Rectifiers; solid state diodes and transistors; solar cells; vacuum tubes; batteries G6C - Analog and digital integrated circuits (IC's); microprocessors; memory; I/O devices; microwave IC's (MMIC's); display devices
G7	PRACTICAL CIRCUITS	G7A - Power supplies; transmitters and receivers; filters; schematic symbols G7B - Digital circuits (gates, flip-flops, shift registers); amplifiers and oscillators
G8	SIGNALS AND EMISSIONS	G8A - Carriers and modulation: AM; FM; single and double sideband ; modulation envelope; deviation; overmodulation G8B - Frequency mixing; multiplication; HF data communications; bandwidths of various modes

General Class License Examination Question Pool - Element 3		
Sub	**Title**	**Sections**
G9	ANTENNAS AND FEED-LINES	G9A - Antenna feedlines: characteristic impedance, and attenuation; SWR calculation, measurement and effects; matching networks G9B - Basic antennas G9C - Directional antennas G9D - Specialized antennas
G0	ELECTRICAL AND RF SAFETY	G0A - RF safety principles, rules and guidelines; routine station evaluation G0B - Safety in the ham shack: electrical shock and treatment, grounding, fusing, interlocks, wiring, antenna and tower safety

Subelement G1 - Commission's Rules

G1A01 (C) [97.301(d)]
On which of the following bands is a General Class license holder granted all amateur frequency privileges?
A. 20, 17, and 12 meters
B. 160, 80, 40, and 10 meters
C. 160, 30, 17, 12, and 10 meters
D. 160, 30, 17, 15, 12, and 10 meters

If you go to Part 97, you will see that a General Class operator has frequency privileges on 160, 80/75, 40, 30, 20, 17, 15, 12, and 10 meters. However, if you look closely, you will see that General-Class amateurs have full access across the entire band only on 160, 30, 17, 12, and 10 meters. This makes Answer **C** the correct choice. The other choices include bands where General-Class amateurs do not have full access across the entire band.

G1A02 (B) [97.305]
On which of the following bands is phone operation prohibited?
A. 160 meters
B. 30 meters
C. 17 meters
D. 12 meters

If you inspect Part 97, you will see that only RTTY and data are permitted on the 30-meter band. Since we are looking for the band that does not permit phone, this makes Answer **B** the right choice. The other bands that are choices here permit phone operations.

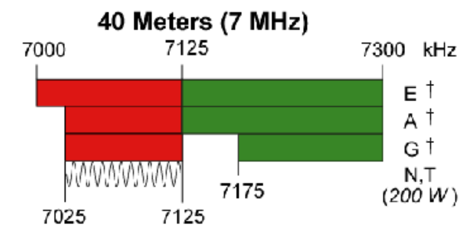
G1A03 (B) [97.305]
On which of the following bands is image transmission prohibited?
A. 160 meters
B. 30 meters
C. 20 meters
D. 12 meters

From the last question, you should be able to spot the correct answer here. Since we just saw that the 30-meter band only allows RTTY and data, it does not allow image transmission so the correct choice is Answer **B**.

G1A04 (D) [97.303(s)]
Which amateur band restricts communication to specific channels, using only USB voice, and prohibits all other modes, including CW and data?
A. 11 meters
B. 12 meters
C. 30 meters
D. 60 meters

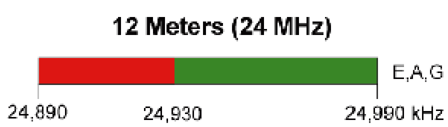
The key here is “specific channels” for USB voice. That is found in Part 97 for the 60-meter band. This makes Answer **D** the right choice. The other bands do not have the restrictions as phrased in the question.

G1A05 (A) [97.301(d)]
Which of the following frequencies is in the General Class portion of the 40 meter band?
A. 7.250 MHz
B. 7.500 MHz
C. 40.200 MHz
D. 40.500 MHz



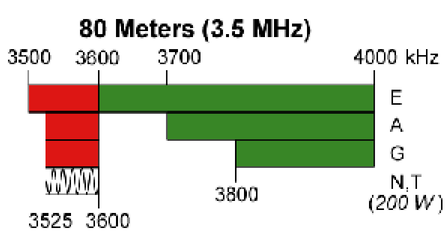
The 40-meter graphic shows that the band runs from 7 MHz to 7.3 MHz. Of the choices given, only Answer **A,** 7.250 MHz, is within that range. The others are then incorrect choices.

G1A06 (D) [97.301(d)]
Which of the following frequencies is in the 12 meter band?
A. 3.940 MHz
B. 12.940 MHz
C. 17.940 MHz
D. 24.940 MHz



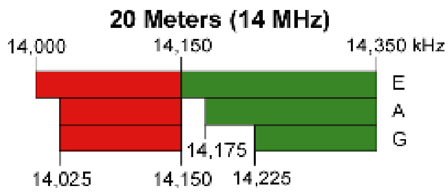
The 12-meter band graphic shows that the band runs from 24.890 MHz to 24.990 MHz. Only Answer **D** is in this range so that is the correct choice. The other choices are out of the band.

G1A07 (C) [97.301(d)]
Which of the following frequencies is within the General class portion of the 75 meter phone band?
A. 1875 kHz
B. 3750 kHz
C. 3900 kHz
D. 4005 kHz



The 75-meter phone band for General Class operators runs from 3800 to 4000 kHz. 3750 kHz is in the pone band but the Extra Class portion and not the General Class portion so Answer B is incorrect. Answer **C** is correct because 3900 kHz is in the General Class portion of the band. Answers A and D are to distract you.

G1A08 (C) [97.301(d)]
Which of the following frequencies is within the General Class portion of the 20 meter phone band?
A. 14005 kHz
B. 14105 kHz
C. 14305 kHz
D. 14405 kHz



The reasoning here is similar to that in the previous question: the General Class portion of the 20-meter band is from 14225 kHz to 14350 kHz so Answer **C** is the only choice given in this range. The other choices are outside this region.

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G1A09 (C) [97.301(d)]
Which of the following frequencies is within the General Class portion of the
80 meter band?
A. 1855 kHz
B. 2560 kHz
C. 3560 kHz
D. 3650 kHz
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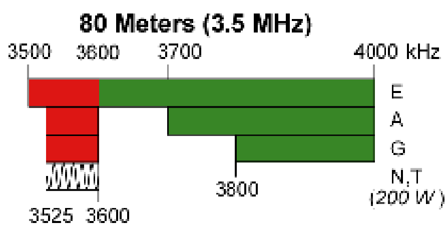

The amateur 80-m band runs from 3500 kHz through 3750 kHz. The General Class portion runs from 3525 kHz to 3600 kHz. This makes Answer **C**, 3560 kHz, the right choice. Be careful with Answer D because it is in the Extra Class part of the band and not the General Class portion. Answers A and B re there to distract you.

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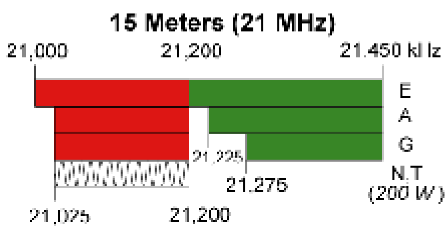
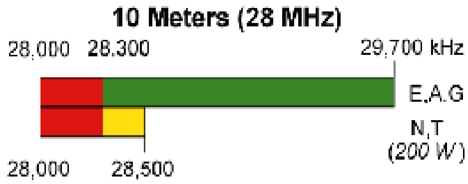
G1A10 (C) [97.301(d)]
Which of the following frequencies is within the General Class portion of the
15 meter band?
A. 14250 kHz
B. 18155 kHz
C. 21300 kHz
D. 24900 kHz
```



By looking at the band graphic, you should be able to spot Answer **C**, 21300 kHz, as the right choice for this question. Answer D is close but it is outside the band. The other choices are just to distract you.

```
G1A11 (D) [97.301(d)]
Which of the following frequencies is available to a control operator holding
a General Class license?
A. 28.020 MHz
B. 28.350 MHz
C. 28.550 MHz
D. All of these answers are correct
```



If we look at the 10-meter band graphic, we can see that the frequencies in Answers A, B, and C are all available to General Class operators. This makes Answer **D** the correct choice.

G1A12 (B) [97.301]
When a General Class licensee is not permitted to use the entire voice portion of a particular band, which portion of the voice segment is generally available to them?
A. The lower end
B. The upper end
C. The lower end on frequencies below 7.3 MHz and the upper end on frequencies above 14.150 MHz
D. The upper end on frequencies below 7.3 MHz and the lower end on frequencies above 14.150 MHz

If you inspect the band graphics on the previous questions, you will see that when the General Class operator is restricted in the band, the allowed frequencies are at the upper end of the band. This makes Answer **B** the right choice. Be careful with Answers C and D because they are trying to sound like the convention on USB vs. LSB for SSB operations. Answer A is the opposite of what is desired.

G1A13 (D) [97.303]
Which amateur band is shared with the Citizens Radio Service?
A. 10 meters
B. 11 meters
C. 12 meters
D. None

The Amateur Service does share bands with other services. However, it does not share any bandwidth with the Citizens Radio Service. This makes Answer **D** the right choice.

G1A14 (C) [97.303]
Which of the following applies when the FCC rules designate the amateur service as a secondary user and another service as a primary user on a band?
A. Amateur stations must obtain permission from a primary service station before operating on a frequency assigned to that station
B. Amateur stations are allowed to use the frequency band only during emergencies
C. Amateur stations are allowed to use the frequency band only if they do not cause harmful interference to primary users
D. Amateur stations may only operate during specific hours of the day, while primary users are permitted 24 hour use of the band

When a service is designated as a secondary user of a band, then Part 97 states that a “station in a secondary service must not cause harmful interference to, and must accept interference from, stations in a primary service.” This makes Answer **C** the only choice that is consistent with Part 97.

G1A15 (D) [97.303]
What must you do if, when operating on either the 30 or 60 meter bands, a station in the primary service interferes with your contact?
A. Notify the FCC's regional Engineer in Charge of the interference
B. Increase your transmitter's power to overcome the interference
C. Attempt to contact the station and request that it stop the interference
D. Stop transmitting at once and/or move to a clear frequency

As we saw in the previous question, the secondary user must accept interference. The only way to get around this is to move to a clear frequency as in Answer **D**. The other choices are not consistent with Part 97 and good operating practice.

G1A16 (A) [97.303(s)]
Which of the following operating restrictions applies to amateur radio stations as a secondary service in the 60 meter band?
A. They must not cause harmful interference to stations operating in other radio services
B. They must transmit no more than 30 minutes during each hour to minimize harmful interference to other radio services
C. They must use lower sideband, suppressed-carrier, only
D. They must not exceed 2.0 kHz of bandwidth

In this band, the Part 97 rules covering the band state that " stations of each service in one Region or sub-Region must operate so as not to cause harmful interference to any service of the same or higher category in the other Regions or sub-Regions." This makes Answer **A** the right choice. The others are just technobabble to distract you.

G1B01 (C) [97.15(a)]
What is the maximum height above ground to which an antenna structure may be erected without requiring notification to the FAA and registration with the FCC, provided it is not at or near a public-use airport?
A. 50 feet
B. 100 feet
C. 200 feet
D. 300 feet

The FCC rule is that owners "of certain antenna structures more than 60.96 meters (200 feet) above ground level at the site or located near or at a public use airport must notify the Federal Aviation Administration and register with the Commission." This makes correct choice answer is **C**. All other answers are incorrect.

G1B02 (D) [97.203(b)]
With which of the following conditions must beacon stations comply?
A. Identification must be in Morse Code
B. The frequency must be coordinated with the National Beacon Organization
C. The frequency must be posted on the Internet or published in a national periodical
D. There must be no more than one beacon signal in the same band from a single location

The rule in Part 97 states that a "beacon must not concurrently transmit on more than 1 channel in the same amateur service frequency band, from the same station location." Only Answer **D** meets the regulation so it is the right choice.

G1B03 (A) [97.1(a)(9)]
Which of the following is a purpose of a beacon station as identified in the FCC Rules?
A. Observation of propagation and reception, or other related activities
B. Automatic Identification of Repeaters
C. Transmission of bulletins of General interest to amateur radio licensees
D. Identifying Net Frequencies

In Part 97, a beacon station is defined as an "amateur station transmitting communications for the purposes of observation of propagation and reception or other related experimental activities." You can see that Answer **A** is the only one that matches the definition for a beacon station.

G1B04 (A) [97.113(b)]
Which of the following must be true before an amateur station may provide news information to the media during a disaster?
A. The information must directly relate to the immediate safety of human life or protection of property and there is no other means of communication available
B. The exchange of such information must be approved by a local emergency preparedness official and transmitted on officially designated frequencies
C. The FCC must have declared a state of emergency
D. Both amateur stations must be RACES stations

The regulation in Part 97 states that an amateur station shall not "engage in any activity related to program production or news gathering for broadcasting purposes, except that communications directly related to the immediate safety of human life or the protection of property may be provided by amateur stations to broadcasters for dissemination to the public where no other means of communication is reasonably available before or at the time of the event." As can be seen, only Answer **A** meets the criterion of Part 97.

G1B05 (D) [97.113(a)(4),(e)]
When may music be transmitted by an amateur station?
A. At any time, as long as it produces no spurious emissions
B. When it is unintentionally transmitted from the background at the transmitter
C. When it is transmitted on frequencies above 1215 MHz
D. When it is an incidental part of a space shuttle or ISS retransmission

Generally, music may not be transmitted. However, Part 97 permits retransmissions "including incidental music, originating on United States Government frequencies between a space shuttle and its associated Earth stations. Prior approval for shuttle retransmissions must be obtained from the National Aeronautics and Space Administration. Such retransmissions must be for the exclusive use of amateur operators. Propagation, weather forecasts, and shuttle retransmissions may not be conducted on a regular basis, but only occasionally, as an incident of normal amateur radio communications." This makes Answer **D** the right choice for this question.

G1B06 (B) [97.113(a)(4) and 97.207(f)]
When is an amateur station permitted to transmit secret codes?
A. During a declared communications emergency
B. To control a space station
C. Only when the information is of a routine, personal nature
D. Only with Special Temporary Authorization from the FCC

The general principle in Part 97 is that an amateur station may not transmit "messages encoded for the purpose of obscuring their meaning." However, there is an exemption to this rule where for space stations, "Space telemetry transmissions may consist of specially coded messages intended to facilitate communications or related to the function of the spacecraft" are permitted. This is part of the control of the space station so Answer **B** is the choice that meets the regulations.

```
G1B07 (B) [97.113(a)(4)]
What are the restrictions on the use of abbreviations or procedural signals in
the amateur service?
A. Only "Q" codes are permitted
B. They may be used if they do not obscure the meaning of a message
C. They are not permitted because they obscure the meaning of a message to FCC
      monitoring stations
D. Only "10-codes" are permitted
```

Here, we may think that we have a re-statement of the previous question but we really have a different situation here. Procedural symbols are not coded transmissions used to disguise the meaning of the transmission. Instead, they are well-known shorthand communications that are commonly-accepted in the community and do not obscure the meaning of the operators if they are used in the commonly-accepted manner. Therefore, the correct answer is **B**. Answer A may sound fine but operators can agree to change the meaning of the codes to obscure the meaning so answer B is the better choice. Answer C is wrong because, if the codes are used properly, the FCC will know the meaning. Answer D is wrong because "10-codes" are not the commonly-accepted codes in the amateur service.

```
G1B08 (D) [97.113(a)(4), 97.113(e)]
Which of the following is prohibited by the FCC Rules for amateur radio
stations?
A. Transmission of music as the primary program material during a contact
B. The use of obscene or indecent words
C. Transmission of false or deceptive messages or signals
D. All of these answers are correct
```

Since each of the choices given in Answers A through C are prohibited, Answer **D** is the correct choice.

```
G1B09 (A) [97.113(a)(3)]
When may an amateur station transmit communications in which the licensee or
control operator has a pecuniary (monetary) interest?
A. Only when other amateurs are being notified of the sale of apparatus
      normally used in an amateur station and such activity is not done on a
      regular basis
B. Only when there is no other means of communications readily available
C. At any time as long as the communication does not involve a third party
D. Never
```

The regulation in Part 97 states that an amateur station may not transmit communications "in which the station licensee or control operator has a pecuniary interest, including communications on behalf of an employer. Amateur operators may, however, notify other amateur operators of the availability for sale or trade of apparatus normally used in an amateur station, provided that such activity is not conducted on a regular basis". The phrasing in Answer **A** is the only choice given that matches part 97 so it is the right answer.

```
G1B10 (C) [97.203(c)]
What is the power limit for beacon stations?
A. 10 watts PEP output
B. 20 watts PEP output
C. 100 watts PEP output
D. 200 watts PEP output
```

The Part 97 rules on beacon stations state that the “transmitter power of a beacon must not exceed 100 W.” This makes Answer **C** the correct choice. The other choices do not match Part 97.

```
G1B11 (C) [97.101(a)]
How does the FCC require an amateur station to be operated in all respects not
covered by the Part 97 rules?
A. In conformance with the rules of the IARU
B. In conformance with amateur radio custom
C. In conformance with good engineering and good amateur practice
D. All of these answers are correct
```

Part 97 states that in “all respects not specifically covered by FCC Rules each amateur station must be operated in accordance with good engineering and good amateur practice.” This matches the phrasing in Answer **C** so that is the correct choice.

```
G1B12 (A) [97.101(a)]
Who or what determines "good engineering and good amateur practice" that apply
to  operation of an amateur station in all respects not covered by the Part 97
rules?
A. The FCC
B. The Control Operator
C. The IEEE
D. The ITU
```

The FCC regulates amateur radio practices in the United States and not the ITU so choice D is wrong but Answer **A** is correct. The IEEE is a professional group and has no regulatory function so choice C is wrong. Answer B would allow the operator to set standards so that is not a good choice.

```
G1B13 (A) [97.121(a)]
What restrictions may the FCC place on an amateur station that is causing
interference to a broadcast receiver of good engineering design?
A. Restrict the amateur station operation to times other than 8 pm to 10:30 pm
      local time every day, as well as on Sundays from 10:30 am to 1 pm local
      time
B. Restrict the amateur station from operating at times requested by the owner
      of the receiver
C. Restrict the amateur station to operation only during RACES drills
D. Restrict the amateur station from operating at any time
```

The regulations in Part 97 state that if “the operation of an amateur station causes general interference to the reception of transmissions from stations operating in the domestic broadcast service when receivers of good engineering design, including adequate selectivity characteristics, are used to receive such transmissions, and this fact is made known to the amateur station licensee, the amateur station shall not be operated during the hours from 8 p.m. to 10:30 p.m., local time, and on Sunday for the additional period from 10:30 a.m. until 1 p.m., local time, upon the frequency or frequencies used when the interference is created.” Only Answer **A** matches the rules.

```
G1C01 (A) [97.313(c)(1)]
What is the maximum transmitting power an amateur station may use on 10.140
MHz?
A. 200 watts PEP output
B. 1000 watts PEP output
C. 1500 watts PEP output
D. 2000 watts PEP output
```

For this question, and the ones following it on power limits, we need to remember one fact: the FCC maximum power limits are either 1500 Watts or 200 Watts under normal operating conditions. Generally, the 200-Watt limit is on the Novice/Tech+ parts of the radio spectrum below 28.1 MHz while the other bands, except for 30 meters, we can use up to 1500 Watts. All other power choices are to distract you and can be ignored. Our right answer here comes from either answer A or answer C. The 30-meter band is a special case and everyone is limited to a maximum power of 200 Watts. Therefore, the correct answer among these choices is **A**. Answers B and D are to distract you.

```
G1C02 (C) [97.313(a),(b)]
What is the maximum transmitting power an amateur station may use on the 12
meter band?
A. 1500 PEP output, except for 200 watts PEP output in the novice portion
B. 200 watts PEP output
C. 1500 watts PEP output
D. Effective radiated power equivalent to 50 watts from a half wave dipole
```

This question has been withdrawn.

```
G1C03 (B) [97.313]
What is the maximum transmitting power a General class licensee may use when
operating between 7025 and 7125 kHz?
A. 200 watts PEP output
B. 1500 watts PEP output
C. 1000 watts PEP output
D. 2000 watts PEP output
```

Our right answer here comes from either answer A or answer C. Even though this is over the Novice/Tech+ part of the spectrum we can use up to the full legal limit of 1500 Watts because we are General Class operators. Therefore, the correct answer among these choices is **B**. Answers C and D are to distract you.

```
G1C04 (A) [97.313]
What limitations, other than the 1500 watt PEP limit, are placed on
transmitter power in the 14 MHz band?
A. Only the minimum power necessary to carry out the desired communications
      should be used
B. Power must be limited to 200 watts when transmitting between 14.100 MHz and
      14.150 MHz
C. Power should be limited as necessary to avoid interference to another radio
      service on the frequency
D. Effective radiated power cannot exceed 3000 watts
```

Even though we may be permitted to use up to 1500 W for transmissions, good practice and the Part 97 regulations state that an “amateur station must use the minimum transmitter power necessary to carry out the desired communications.” This principle is found in Answer **A** so that is the correct choice.

```
G1C05 (C) [97.313]
What is the maximum transmitting power a station with a General Class control
operator may use on the 28 MHz band?
A. 100 watts PEP output
B. 1000 watts PEP output
C. 1500 watts PEP output
D. 2000 watts PEP output
```

Here the question is a bit tricky. Our right answer will still be either 200 W or 1500 W. Also, the 28 MHz frequency band has a Novice/Tech+ sub-band. However, the wording of the rules in Part 97 is that the 200-W restriction is limited in the 28.1 to 28.5 MHz segment only when "the control operator is a Novice Class operator or a Technician Class operator who has received credit for proficiency in telegraphy in accordance with the international requirements." Since this case involves a General Class operator, there is no 200-W restriction on power limits. Therefore, we can operate at full level or 1500 Watts and the correct answer among these choices is **C**. The other answers are to distract you.

```
G1C06 (D) [97.313(b)]
What is the maximum transmitting power an amateur station may use on 1825 kHz?
A. 200 watts PEP output
B. 1000 watts PEP output
C. 1200 watts PEP output
D. 1500 watts PEP output
```

Our right answer here comes from either answer A or answer D. Since Novice/Tech+ operators have no privileges on the 160-meter band, we can use up to the full legal limit of 1500 Watts with the reminder that good operating practice says to never use more power than necessary. Therefore, the correct answer among these choices is **D**. Answers B and C are to distract you.

```
G1C07 (C) [97.303(s)]
Which of the following is a requirement when a station is transmitting on
the 60 meter band?
A. Transmissions may only use Lower Sideband (LSB)
B. Transmissions must use only CW or Data modes
C. Transmissions must not exceed an effective radiated power of 50 Watts PEP
      referred to a dipole antenna
D. Transmissions must not exceed an effective radiated power of 200 Watts PEP
      referred to a dipole antenna
```

The Part 97 rules covering 60 meters state that an "amateur station having an operator holding a General, Advanced or Amateur Extra Class license may only transmit single sideband, suppressed carrier, (emission type 2K8J3E) upper sideband on the channels 5332 kHz, 5348 kHz, 5368 kHz, 5373 kHz, and 5405 kHz. Amateur operators shall ensure that their transmission occupies only the 2.8 kHz centered around each of these frequencies. Transmissions shall not exceed an effective radiated power (e.r.p) of 50 W PEP. For the purpose of computing e.r.p. the transmitter PEP will be multiplied with the antenna gain relative to a dipole or the equivalent calculation in decibels." By the rules, Answers A, B and D are excluded. Only Answer **C** is consistent with the Part 97 rules.

```
G1C08 (D) [97.305(c) and 97.307(f)(3)]
What is the maximum symbol rate permitted for RTTY emissions transmitted on
frequency bands below 28 MHz?
A. 56 kilobaud
B. 19.6 kilobaud
C. 1200 baud
D. 300 baud
```

Digital transmissions occupy about 1 Hertz of bandwidth for every bit per second of data rate. RTTY is a digital transmission and for these frequency bands, "the symbol rate must not exceed 300 bauds" so answer **D** is the correct choice. Answer A is for above 2 meters, answer B is for above 28 MHz (above the 10-meter band), and answer C is for on the 10-meter band while the question is directed at frequencies below it.

G1C09 (C) [97.305(c) and 97.307(f)(5)]
What is the maximum symbol rate permitted for packet emission transmissions on the 2 meter band?
A. 300 baud
B. 1200 baud
C. 19.6 kilobaud
D. 56 kilobaud

Now we have moved the digital transmission to a higher frequency so we can move the data rate to a higher baud. On 2 meters, the "symbol rate must not exceed 19.6 kilobauds" so the correct choice is **C**. Choice A is for below 10 meters while choice B is for use on 10 meters. Choice D requires more bandwidth so it is only allowed above 2 meters.

G1C10 (C) [97.305(c) and 97.307(f)(4)]
What is the maximum symbol rate permitted for RTTY or data emission transmissions on the 10 meter band?
A. 56 kilobaud
B. 19.6 kilobaud
C. 1200 baud
D. 300 baud

Packet emissions are digital emissions but now we have moved **onto** the 10-meter band where the spectrum is less crowded. Therefore the FCC stipulates that the "symbol rate must not exceed 1200 bauds" and the correct answer is **C**. Read the question carefully because the previous questions were concerned about operating **below** 10 meters and this question is operating **on** 10 meters so answer D is out. Answer A is for use above 2 meters while answer B is for use at 2 meters and 6 meters.

G1C11 (B) [97.305(c) and 97.307(f)(5)]
What is the maximum symbol rate permitted for RTTY or data emission transmissions on the 6 and 2 meter bands?
A. 56 kilobaud
B. 19.6 kilobaud
C. 1200 baud
D. 300 baud

Here we are back at 2 meters (and 6 meters) and both of these are higher in frequency than 10 meters so we can run at 19.6 kilobaud making the correct answer **B**. Answer C is for use on 10 meters while answer D is for use below 10 meters. Answer A is for use on the bands **above** 2 meters.

G1C12 (A) [97.305(c) and 97.307(f)(5)]
What is the maximum authorized bandwidth for RTTY, data or multiplexed emissions using an unspecified digital code transmitted on the 6 and 2 meter bands?
A. 20 kHz
B. 50 kHz
C. The total bandwidth shall not exceed that of a single-sideband phone emission
D. The total bandwidth shall not exceed 10 times that of a CW emission

These are all digital transmission techniques so the same restrictions we had above still apply. Since we are talking the VHF bands, the restriction is to 19.6 kilobaud and each baud requires about 1 Hz of bandwidth to transmit it so the correct answer is 20 kHz or answer **A**. 50 kHz is more bandwidth than that allowed at VHF so it is eliminated. Restrictions C and D do not appear in the FCC rules so they are eliminated.

```
G1C13 (A) [97.303s]
What is the maximum bandwidth permitted by FCC rules for amateur radio
stations when operating on USB frequencies in the 60-meter band?
A. 2.8 kHz
B. 5.6 kHz
C. +/-2.8 kHz
D. 3 kHz
```

As we saw above, the Part 97 rules require that amateur “operators shall ensure that their transmission occupies only the 2.8 kHz centered around each of these” permitted frequencies. This corresponds to Answer **A**. Be careful with answer C since it would give the transmission twice the authorized bandwidth.

```
G1D01 (C) [97.119(f)(2)]
What is the proper way to identify when transmitting on General class
frequencies if you have a CSCE for the required elements but your upgrade from
Technician has not appeared in the ULS database?
A. Give your call sign followed by the words "General class"
B. No special identification is needed, since your license upgrade would
      already be shown in the FCC's database
C. Give your call sign followed by the words "temporary AG"
D. Give your call sign followed the abbreviation "CSCE"
```

When the license information appears in the ULS database, it is official. Until then, Part 97 states that when “the control operator is a person who is exercising the rights and privileges authorized by Sec. 97.9(b) of this part, an indicator must be included after the call sign as follows: ... (2) For a control operator who has requested a license modification from Novice, Technician, or Technician Plus Class to General Class: AG....” This makes Answer **C** correct since it has the right formulation.

```
G1D02 (C) [97.509(b)(3)(i)]
What license examinations may you administer when you are an accredited VE
holding a General Class operator license?
A. Novice
B. General
C. Technician
D. All elements
```

If one inspects Part 97, one will see that the only examination that a General Class operator can prepare is the Technician examination so Answer **C** is the correct choice. The Novice examination no longer exists so Answer A is incorrect. Generals are not permitted to prepare exams for other Generals so Answer B is also incorrect. Since A and B are incorrect, Answer D is also incorrect.

```
G1D03 (C) [97.9(b)]
Which of the following band segments may you operate on if you are a
Technician Class operator and have a CSCE for General Class privileges?
A. Only the Technician band segments until your upgrade is posted on the FCC
      database
B. Only on the Technician band segments until your license arrives in the mail
C. On any General Class band segment
D. On any General Class Band segment except 30 and 60 meters
```

The general rule in Part 97 for a licensed operator holding a CSCE is that operator “is authorized to exercise the rights and privileges of the higher operator class until final disposition of the application or until 365 days following the passing of the examination, whichever comes first.” This means that the operator has access to the General Class band portions as in Answer **C**. The other choices do not match the regulations.

G1D04 (A) [97.509(a)(b)]
Which of the following are requirements for administering a Technician Class operator examination?
A. At Least three VEC-accredited General Class or higher VEs must be present
B. At least two VEC-accredited General Class or higher VEs must be present
C. At least two General Class or higher VEs must be present, but only one need be VEC accredited
D. At least three VEs of Technician Class or higher must be present

The FCC requires that each "examination for an amateur operator license must be administered by a team of at least 3 VEs at an examination session coordinated by a VEC". The minimum license grade to be a VE is the General Class so the correct answer is **A**. Answers B is wrong because the minimum number of VEs is not correct. Answer C is wrong because the number of VEs is incorrect and it does not require proper accreditation. Answer D is wrong because it does not mention accredited VEs at all so it cannot be correct.

G1D05 (D) [97.509(b)(3)(i)]
Which of the following is sufficient for you to be an administering VE for a Technician Class operator license examination?
A. Notification to the FCC that you want to give an examination
B. Receipt of a CSCE for General class
C. Possession of properly obtained telegraphy and written examinations
D. A FCC General class or higher license and VEC accreditation

To be eligible to participate as a VE, the operator must have at least a General Class license in hand from the FCC and a valid accreditation so the correct answer is **D**. Answer A may sound fine but the FCC does not get directly involved with the administering of the exams so answer A is out. Answer B cannot be correct because the FCC requires that the VE actually have their license grant while the CSCE is really a temporary permit until the paperwork is validated and finalized and the license grant is issued. Answer C is wrong because it says nothing about license grades or accreditation.

G1D06 (A) [97.119(f)(2)]
When must you add the special identifier "AG" after your call sign if you are a Technician Class licensee and have a CSCE for General Class operator privileges?
A. Whenever you operate using General class frequency privileges
B. Whenever you operate on any amateur frequency
C. Whenever you operate using Technician frequency privileges
D. A special identifier is not required as long as your General class license application has been filed with the FCC

The CSCE must be used with your new privileges until your license grant has been fully processed and entered into the FCC data base. Answer B may sound correct but you do not need the AG identification if you are operating on the Technician-privilege frequencies so answers B and C are wrong. Answer D may sound correct but the license grant is finalized when it is entered into the data base – not when it has been only received by the FCC but not processed. The correct choice is answer **A**.

G1D07 (B) [97.509(h)]
Who is responsible at a Volunteer Exam Session for determining the correctness of the answers on the exam?
A. The FCC
B. The administering VEs
C. The VEC
D. The local VE team liaison

The FCC requires that upon "completion of each examination element, the administering VEs must immediately grade the examinee's answers. The administering VEs are responsible for determining the correctness of the examinee's answers." This makes Answer **B** the choice that matches the regulations.

```
G1D08 (B) [97.509(i)]
What document must be issued to a person that passes an exam element?
A. FCC form 605
B. CSCE
C. CCSA
D. NCVEC form 605
```

The FCC requires that the VE team "must issue a CSCE to an examinee who scores a passsing grade on an examination element." This corresponds with Answer **B**. Be careful with Answer C because it looks similar.

```
G1D09 (C) [97.3(a)(15)]
How long is a Certificate of Successful Completion of Examination(CSCE)valid
for exam element credit?
A. 30 days
B. 180 days
C. 365 days
D. For as long as your current license is valid
```

The CSCE shows each examination element "the examinee passed within the previous 365 days." Answer **C** matches this regulation in Part 97 so it is the correct choice.

```
G1D10 (B) [97.509(b)(2)]
What is the minimum age that one must be to qualify as an accredited Volunteer
Examiner?
A. 12 years
B. 18 years
C. 21 years
D. There is no age limit
```

Part 97 specifies that a VE must be "at least 18 years of age." This makes Answer **B** the correct choice.

```
G1D11 (B) [97.509 (b)(3)]
What criteria must be met for a non U.S. citizen to be an accredited Volunteer
Examiner?
A. The person must be a resident of the U.S. for a minimum of 5 years
B. The person must hold a U.S. amateur radio license of General class or above
C. The person's home citizenship must be in the ITU 2 region
D. None of these answers is correct; non U.S. citizens cannot be volunteer
      examiners
```

The FCC requires that a VE be "a person who holds an amateur operator license of the class ... Amateur Extra, Advanced or General Class...." so Answer B is the right choice. Since there is no citizenship requirement, Answers A, C, and D is incorrect.

G1D12 (C) [97.509(b)(1)]
Volunteer Examiners are accredited by what organization?
A. The Federal Communications Commission
B. The Universal Licensing System
C. A Volunteer Examiner Coordinator
D. The Wireless Telecommunications Bureau

Looking at Part 97, we see that each "administering VE must ... Be accredited by the coordinating VEC ...." This makes Answer **C** the right choice. The FCC does not certify VE's so Answers A and D are incorrect. The ULS stores license information but it cannot certify a VE so Answer B is also incorrect.

G1D13 (D) [97.509]
When may you participate as a VE in administering an amateur radio license examination?
A. Once you have notified the FCC that you want to give an examination
B. Once you have a Certificate of Successful Completion of Examination (CSCE) for General class
C. Once your General class license appears in the FCC's ULS database
D. Once you have been granted your General class license and received your VEC accreditation

The rules in Part 97 state that you must have your General Class license or higher and be accredited by a VEC to participate so Answer **D** is correct. Answer A is silly. Answers B and C do not reference accreditation so they are not correct choices.

G1E01 (A) [97.115(b)(2)]
Which of the following would disqualify a third party from participating in stating a message over an amateur station?
A. The third party is a person previously licensed in the amateur service whose license had been revoked
B. The third party is not a U.S. citizen
C. The third party is a licensed amateur
D. The third party is speaking in a language other than English, French, or Spanish

The paragraph in the Part 97 regulations that is the subject of this question states that the "third party is not a prior amateur service licensee whose license was revoked; suspended for less than the balance of the license term and the suspension is still in effect; suspended for the balance of the license term and relicensing has not taken place; or surrendered for cancellation following notice of revocation, suspension or monetary forfeiture proceedings. The third party may not be the subject of a cease and desist order which relates to amateur service operation and which is still in effect." Notice that there is no nationality, license, or language restriction in the rule. Therefore, Answer **A** is the right choice.

G1E02 (D) [97.205(a)]
When may a 10 meter repeater retransmit the 2 meter signal from a station having a Technician Class control operator?
A. Under no circumstances
B. Only if the station on 10 meters is operating under a Special Temporary Authorization allowing such retransmission
C. Only during an FCC-declared General state of communications emergency
D. Only if the 10 meter control operator holds at least a General class license

Believe it or not, a Technician Class operator can get on the HF bands if they do it the right way so answer A is eliminated. Part 97 states that a "holder of a Technician, General, Advanced or Amateur Extra Class operator license may be the control operator of a repeater, subject to the privileges of the class of operator license held." So each transmitter may only operate on those frequencies for which the control operator has a license grant. But every time a message is passed through a new transmitter, it is "re-born" and it falls under the license of the transmitter's control operator. Therefore, if the repeater control operator has General Class privileges as a minimum, the new transmission can be sent on 10-meters and answer **D** is the correct choice. Choices B and C are not relevant here.

```
G1E03 (A) [97.3(a)(39)]
What kind of amateur station simultaneously retransmits the signals of other
stations on another channel?
A. Repeater Station
B. Beacon Station
C. Telecommmand Station
D. Relay Station
```

There are two station types that are close here: *repeater* and *relay*. A repeater station is an "amateur station that simultaneously retransmits the transmission of another amateur station on a different channel or channels." This shows that the correct choice is answer **A** but read carefully because answer D looks close. Answers B and C are real amateur stations for other purposes and are used here to distract you.

```
G1E04 (D) [97.13(b),97.311(b), 97.303]
Which of the following conditions require an amateur radio station to take
specific steps to avoid harmful interference to other users or facilities?
A. When operating within one mile of an FCC Monitoring Station
B. When using a band where the amateur service is secondary
C. When a station is transmitting spread spectrum emissions
D. All of these answers are correct
```

Each of the choices specified in Answers A, B, and C are explicitly called out in the Part 97 regulations as conditions to avoid harmful interference. Therefore, the best choice is Answer **D**.

```
G1E05 (C) [97.115(a)(2), 97.117]
What types of messages for a third party in another country may be transmitted
by an amateur station?
A. Any message, as long as the amateur operator is not paid
B. Only messages for other licensed amateurs
C. Only messages relating to amateur radio or remarks of a personal character,
      or messages relating to emergencies or disaster relief
D. No messages may be transmitted to foreign countries for third parties
```

Answer D may sound correct because the Amateur Service is intended to be a person-to-person communications service but this choice is not correct because the United States has agreements with other countries to allow third party messages to pass. The rules covering third-party communications to a foreign country state that such communications are permitted with any "station within the jurisdiction of any foreign government when transmitting emergency or disaster relief communications and any station within the jurisdiction of any foreign government whose administration has made arrangements with the United States to allow amateur stations to be used for transmitting international communications on behalf of third parties. No station shall transmit messages for a third party to any station within the jurisdiction of any foreign government whose administration has not made such an arrangement. This prohibition does not apply to a message for any third party who is eligible to be a control operator of the station." Additionally, "Transmissions to a different country, where permitted, shall be limited to communications incidental to the purposes of the amateur service and to remarks of a personal character. The correct choice is answer **C** because it is in compliance with the regulations. Answer B is incorrect because third-party communications are generally not for other licensed amateurs. Answer A is incorrect because "any message" might not fall within the restrictions given, even if the amateurs are not paid.

G1E06 (A) [97.205(c)]
Which of the following applies in the event of interference between a coordinated repeater and an uncoordinated repeater?
A. The licensee of the non-coordinated repeater has primary responsibility to resolve the interference
B. The licensee of the coordinated repeater has primary responsibility to resolve the interference
C. Both repeater licensees share equal responsibility to resolve the interference
D. The frequency coordinator bears primary responsibility to resolve the interference

The Part 97 rules covering repeater interference state that "Where the transmissions of a repeater cause harmful interference to another repeater, the two station licensees are equally and fully responsible for resolving the interference unless the operation of one station is recommended by a frequency coordinator and the operation of the other station is not. In that case, the licensee of the non-coordinated repeater has primary responsibility to resolve the interference." As we can see, Answer **A** matches the regulation so the non-coordinated repeater licensee has the responsibility to resolve the interference in this case.

G1E07 (C) [97.115(a)(2)]
With which of the following is third-party traffic prohibited, except for messages directly involving emergencies or disaster relief communications?
A. Countries in ITU Region 2
B. Countries in ITU Region 1
C. Any country other than the United States, unless there is a third-party agreement in effect with that country
D. Any country which is not a member of the Internal Amateur Radio Union (IARU)

Going back a question to the third-party rules, we can see there was no restriction as to ITU regions so answers A and B are incorrect. Nothing was mentioned about the IARU so answer D is also incorrect. However, the Part 97 rules did specify that there needed to be a third-party agreement in effect so Answer **C** is the correct choice.

G1E08 (B) [97.115(a)(b)]
Which of the following is a requirement for a non-licensed person to communicate with a foreign amateur radio station from a US amateur station at which a licensed control operator is present?
A. Information must be exchanged in English
B. The foreign amateur station must be in a country with which the United States has a third party agreement
C. The control operator must have at least a General class license
D. All of these answers are correct

Based on what we have seen in recent questions, you should be able to spot Answer **B** as the correct choice. None of the restrictions found in Answers A and C were in the Part 97 regulations. Since A and C are incorrect, Answer D is also incorrect.

G1E09 (C) [97.119(b)(2)]
What language must you use when identifying your station if you are using a language other than English in making a contact?
A. The language being used for the contact
B. Any language if the US has a third party agreement with that country
C. English
D. Any language of a country that is a member of the ITU

When making a legal station identification while using phone emissions in the United States, the identification is to be by “a phone emission in the English language.” This makes answer C the right choice. You can use languages other than English for the QSO but not the identification so all other choices are out.

G1E10 (D) [97.115(a)(2)]
Which of the following is a permissible third party communication during routine amateur radio operations?
A. Permitting an unlicensed person to speak to a licensed amateur anywhere in the world
B. Sending a business message for another person, as long it is for a non-profit organization
C. Sending a business message for another person, as long as the control operator has no pecuniary interest in the message
D. Sending a message to a third party through a foreign station, as long as that person is a licensed amateur radio operator

If we go back to the third-party rules above, we can see that Answer **D** is the only one mentioned in Part 97 so it is the best choice. Business messages are not permitted so answers B and C are incorrect. Answer A is too general so it is not a good choice to answer this question.

Subelement G2 - Operating Procedures

G2A01 (A)
Which sideband is most commonly used for phone communications on the bands above 20 meters?
A. Upper Sideband
B. Lower Sideband
C. Vestigial Sideband
D. Double Sideband

This is a question based on operational practice that has grown up over the years and not on Part 97 rules. If you have not observed HF operations, it might not make much sense until you get used to the procedure. The general rule is that below 14 MHz or bands longer than 20 meters, use lower side band while above 14 MHz or at the 20-meter band and shorter wavelengths, use upper side band. Later, when we discuss the 60-meter band we will a regulatory difference to this general rule. Since we are above 20 meters, we choose upper side band and the correct answer is **A**. Answer B is the other good choice but it is for operating below (lower in frequency) the 20-meter band. Choice C is a mode designed for TV transmission and not phone transmission so it is also incorrect. Double side band is standard AM and it is not a single sideband mode since both sidebands are transmitted.

G2A02 (B)
Which sideband is commonly used on the 160, 75, and 40 meter bands?
A. Upper Sideband
B. Lower Sideband
C. Vestigial Sideband
D. Double Sideband

Using the operating rule from the previous question, we can spot the right answer, Lower Sideband, as Answer **B** so that is the right choice. Answer A is for higher frequencies so it is incorrect. The other two are still wrong as well.

G2A03 (A)
Which sideband is commonly used in the VHF and UHF bands?
A. Upper Sideband
B. Lower Sideband
C. Vestigial Sideband
D. Double Sideband

Because the VHF and UHF bands are above 20-meters in frequency, we can see that the right choice, Upper Sideband, is found in Answer **A**. Answer B violates the operational protocol in these bands so it is incorrect. Answers C and D are still there to distract you.

G2A04 (A)
Which mode is most commonly used for voice communications on the 17 and 12 meter bands?
A. Upper Sideband
B. Lower Sideband
C. Vestigial Sideband
D. Double Sideband

Because 17 and 12 meters are higher in frequency then the 20-meter band, the correct choice is, again, Upper Sideband which makes Answer **A** the right choice.

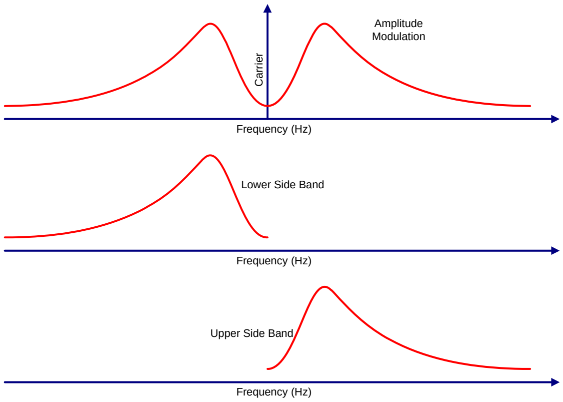
G2A05 (C)
Which mode of voice communication is most commonly used on the High Frequency Amateur bands?
A. FM
B. AM
C. SSB
D. PM

Since we have been stressing SSB on the past few questions, you may suspect that the correct answer is **C** and you are correct. But why? In the HF bands, the operating frequency space is limited so we wish to have the smallest "footprint" on the band. Here, FM and PM will have the widest bandwidth – around 15 kHz, AM is the next with around 6 kHz and SSB with around 3 kHz. This makes SSB technically the best choice.

G2A06 (B)
Which of the following is an advantage when using single sideband as compared to other voice modes on the HF amateur bands?
A. Very high fidelity voice modulation
B. Less bandwidth used and high power efficiency
C. Ease of tuning on receive
D. Less subject to static crashes (atmospherics)

Actually, FM and PM are superior in static protection and higher fidelity modulation than SSB so answers A and D are eliminated. With modern receivers, many modulation are similar in tuning so answer C is not a good choice. However, SSB is superior in bandwidth and power efficiency so Answer **B** is the right choice.

G2A07 (B)
Which of the following statements is true of the single sideband (SSB) voice mode?
A. Only one sideband and the carrier are transmitted; the other sideband is suppressed
B. Only one sideband is transmitted; the other sideband and carrier are suppressed
C. SSB voice transmissions have higher average power than any other mode
D. SSB is the only mode that is authorized on the 160, 75 and 40 meter amateur bands



As we can see in the graphic, SSB has just the designated sideband transmitted without a carrier signal. Answer A is incorrect because it states that the carrier is transmitted. Answer B is the one that correctly describes SSB so it is the right choice. Answer B is incorrect technically. If you look at the band graphics shown earlier, you will see other modes than SSB so answer D is also incorrect.

G2A08 (A)
Which of the following statements is true of single sideband (SSB) voice mode?
A. It is a form of amplitude modulation in which one sideband and the carrier are suppressed
B. It is a form of frequency modulation in which higher frequencies are emphasized
C. It reproduces upper frequencies more efficiently than lower frequencies
D. It is the only voice mode authorized on the HF bands between 14 and 30 MHz

Again, looking at the band graphic above, we can see that Answer **A** is a correct technical description of SSB so it is the correct answer. Answer B is incorrect because SSB is a form of amplitude modulation and not frequency modulation. Answer C is technobabble. Answer D is not found in the regulations so it is incorrect.

G2A09 (D)
Why do most amateur stations use lower sideband on the 160, 75 and 40 meter bands?
A. The lower sideband is more efficient at these frequency bands
B. The lower sideband is the only sideband legal on these frequency bands
C. Because it is fully compatible with an AM detector
D. Current amateur practice is to use lower sideband on these frequency bands

Answers A and C are technobabble – the radio channel does not discriminate between side bands and SSB generally can't be detected with an dual sideband AM receiver. Answer B is incorrect because the FCC regulations do not specify the sideband mode. Answer **D** is a correct statement so it is the right choice.

G2A10 (B)
Which of the following statements is true of VOX operation?
A. The received signal is more natural sounding
B. VOX allows "hands free" operation
C. Frequency spectrum is conserved
D. The duty cycle of the transmitter is reduced

A VOX is a voice-operated relay that keys the transmitter like the Push-To-Talk (PTT) switch does on the microphone. The only effect this relay can have is to allow you "hands free" operation. It cannot process or change the signal in any way. Therefore, answer **B** is the best choice and the other answers are not true based on how a radio really operates.

G2A11 (D)
Which of the following user adjustable controls are usually associated with VOX circuitry?
A. Anti-VOX
B. VOX Delay
C. VOX Sensitivity
D. All of these choices are correct

Because a VOX is energized by sound, any sound can affect its operations – both desired sounds and background noise. All three functions listed in answers A, B, and C can be found in a well-designed VOX assembly. Therefore, the best choice is answer **D**.

G2A12 (B)
What is the recommended way to break into a conversation when using phone?
A. Say "QRZ" several times followed by your call sign
B. Say your call sign during a break between transmissions from the other stations
C. Say "Break" "Break" "Break" and wait for a response
D. Say "CQ" followed by the call sign of either station

When you send QRZ, you are requesting the call sign of a station so Answer A is not a good choice. Answer **B** has the correct operating procedure so it is the right choice. Answer C is bad amateur operating practice so it is incorrect. When you send CQ, you are looking for another station and not trying to enter into an existing conversation so answer D is not a good choice.

G2A13 (C)
What does the expression "CQ DX" usually indicate?
A. A general call for any station
B. The caller is listening for a station in Germany
C. The caller is looking for any station outside their own country
D. This is a form of distress call

The “CQ” means you are looking for a station while the “DX” implies a distant (not one in our country) station. Therefore “CQ DX” is calling for a distant station as in Answer **C**. Answer A would be correct if we are just sending “CQ”. Answer B is to make you chuckle. Answer D is incorrect.

G2B01 (C)
What action should be taken if the frequency on which a net normally meets is in use just before the net begins?
A. Reduce your output power and start the net as usual
B. Increase your power output so that net participants will be able to hear you
C. Ask the stations if the net may use the frequency, or move the net to a nearby clear frequency if necessary
D. Cancel the net for that day

Since no one has exclusive right to a frequency, the only legal action the net control can take is given in answer **C**. Answers A and B are not good operating practice and are eliminated. Answer D is not required so it is out too.

G2B02 (A)
What should be done if a net is about to begin on a frequency you and another station are using?
A. Move to a different frequency as a courtesy to the net
B. Tell the net that they must to move to another frequency
C. Reduce power to avoid interfering with the net
D. Pause between transmissions to give the net a chance to change frequency

While it is not required that you move, operating courtesy says that it would be nice if you did move the QSO and answer **A** is correct. Answers B and C are bad operating practice and are eliminated. Answer D is not required so it is wrong too.

G2B03 (C)
What should you do if you notice increasing interference from other activity on a frequency you are using?
A. Tell the interfering stations to change frequency since you were there first
B. Report the interference to your local Amateur Auxiliary Coordinator
C. Move your contact to another frequency
D. Turn on your amplifier

Best operating practice says to avoid causing interference. The best action to take would be to QSY as in answer **C** and change frequencies. Answer A violates the rule that no one has exclusive access to a frequency. Answer B will not eliminate the interference so it is eliminated. Answer D is bad operating practice so it is out too.

G2B04 (B)
What minimum frequency separation between CW signals should be allowed to minimize interference?
A. 5 to 50 Hz
B. 150 to 500 Hz
C. 1 to 3 kHz
D. 3 to 6 kHz

Here, you need to know that CW transmissions are around 150 Hz wide in frequency. Therefore, answer **B** gives adequate user separation. Since we are looking for the minimum frequency separation in this question, this makes answer B the best choice of the answers given. Answer A will have the signals overlap and we would still have interference. Answers C and D are unnecessarily large separations and, since the question is asking for the minimum frequency separation, they are not as good answers as answer B.

G2B05 (B)
What minimum frequency separation between SSB signals should be allowed to minimize interference?
A. Between 150 and 500 Hz
B. Approximately 3 kHz
C. Approximately 6 kHz
D. Approximately 10 kHz

This is the same type of question as the previous one. With this one, you need to know that SSB transmissions are around 3 kHz wide in frequency. Therefore, answer **B** gives adequate separation between the users so it is the best choice of the ones given. Answer A would have the users' signals overlap and we would still have interference. Answers C and D are unnecessarily large separations and, since we are asked again for the minimum separation, they are not as good choices as is answer B.

G2B06 (B)
What minimum frequency separation between 170 Hz shift RTTY signals should be allowed to minimize interference?
A. 60 Hz
B. 250 to 500 Hz
C. Approximately 3 kHz
D. 170 Hz

Next we examine a digital signal. Here, you need to know that RTTY transmissions are around 350 Hz wide (2x 170 Hz)`in frequency. Therefore, answer **B** gives adequate separation between the users so it is the best choice of the answers given. Answers A and D will have the users' signals overlap and we would still have interference. Answer C is unnecessarily large separations and, since we are still looking for the minimum separation, it is not as good choices as is answer B.

G2B07 (A)
What is a band plan?
A. A voluntary guideline for band use beyond the divisions established by the FCC
B. A guideline from the FCC for making amateur frequency band allocations
C. A guideline from the ITU for making amateur frequency band allocations
D. A plan devised by a club to best use a frequency band during a contest

The correct definition of a band plan is given in answer **A** so that is the correct choice. The FCC and the ITU do not get into this level of detail on the frequency allocations so answers B and C are incorrect. While the reason given in D may sound like a good idea, the band plans are not established to determine contests or schedules so answer D is out as well.

G2B08 (A)
What is the "DX window" in a voluntary band plan?
A. A portion of the band that should not be used for contacts between stations within the 48 contiguous United States
B. An FCC rule that prohibits contacts between stations within the United States and possessions on that band segment
C. An FCC rule that allows only digital contacts in that portion of the band
D. A portion of the band that has been set aside for digital contacts only

Since Band Plans are more operational agreement than official regulations, answers B and C are not correct. The Band Plan covers more than digital modes so answer D is also incorrect. Since we saw earlier that “DX” was for distant stations, answer **A** is the correct choice.

G2B09 (D)
What should you do to comply with good amateur practice when choosing a frequency for Slow-Scan TV (SSTV) operation?
A. Transmit only on lower sideband
B. Transmit your callsign as an SSTV image for 1 minute to ensure a clear frequency
C. Select a frequency in the portion of the band set aside for digital operation
D. Follow generally accepted band plans for SSTV operation

Each of the actions listed in Answers A, B, and C is individually bad operating practice so they are incorrect choices. Therefore, the correct answer is **D** since it is a correct statement.

G2B10 (D)
What should you do to comply with good amateur practice when choosing a frequency for radio-teletype (RTTY) operation?
A. Call CQ in Morse code before attempting to establish a contact in RTTY
B. Select a frequency in the upper end of the phone band
C. Select a frequency in the lower end of the phone band
D. Follow generally accepted band plans for RTTY operation

Each of the actions listed in Answers A, B, and C is individually bad operating practice so they are incorrect choices. Therefore, the correct answer is **D** since it is a correct statement.

Voluntary Band Plan

The following frequencies are generally recognized for certain modes or activities (all frequencies are in MHz). Nothing in the rules recognizes a net's, group's or any individual's special privilege to any specific frequency. Section 97.101(b) of the Rules states that "Each station licensee and each control operator must cooperate in selecting transmitting channels and in making the most effective use of the amateur service frequencies. No frequency will be assigned for the exclusive use of any station." No one "owns" a frequency. It's good practice—and plain old common sense—for any operator, regardless of mode, to check to see if the frequency is in use prior to engaging operation. If you are there first, other operators should make an effort to protect you from interference to the extent possible given that 100% interference-free operation is an unrealistic expectation in today's congested bands.

1.800-1.830	CW, data and other narrowband modes
1.810	QRP CW calling frequency
1.830-1.840	CW, data and other narrowband modes, intercontinental QSOs only
1.840-1.850	CW; SSB, SSTV and other wideband modes, intercontinental QSOs only
1.850-2.000	CW; phone, SSTV and other wideband modes
3.560	QRP CW calling frequency
3.590	RTTY DX
3.580-3.620	Data
3.620-3.635	Automatically controlled data stations
3.710	QRP Novice/Technician CW calling frequency
3.790-3.800	DX window
3.845	SSTV
3.885	AM calling frequency
3.985	QRP SSB calling frequency
7.040	RTTY DX QRP CW calling frequency
7.080-7.100	Data
7.100-7.105	Automatically controlled data stations
7.110	QRP Novice/Technician CW calling frequency
7.171	SSTV
7.285	QRP SSB calling frequency
7.290	AM calling frequency
10.106	QRP CW calling frequency
10.130-10.140	Data
10.140-10.150	Automatically controlled data stations
14.060	QRP CW calling frequency
14.070-14.095	Data
14.095-14.0995	Automatically controlled data stations
14.100	NCDXF/IARU beacons
14.1005-14.112	Automatically controlled data stations
14.230	SSTV
14.233	SSTV
14.285	QRP SSB calling frequency
14.286	AM calling frequency
18.100-18.105	Data
18.105-18.110	Automatically controlled data stations
21.060	QRP CW calling frequency
21.070-21.090	Data
21.090-21.100	Automatically controlled data stations
21.340	SSTV
21.385	QRP SSB calling frequency
24.920-24.925	Data
24.925-24.930	Automatically controlled data stations
28.060	QRP CW calling frequency
28.070-28.120	Data
28.120-28.189	Automatically controlled data stations
28.200-28.300	Beacons
28.385	QRP SSB calling frequency
28.680	SSTV
29.000-29.200	AM
29.300-29.510	Satellite downlinks
29.520-29.580	Repeater inputs
29.600	FM simplex
29.620-29.680	Repeater outputs

Note
ARRL band plans for frequencies above 28.300 MHz are shown in *The ARRL Repeater Directory* and *The FCC Rule Book*. For detailed packet frequencies, see *QST*, September 1987, page 54, and March 1988, page 51.

G2B11 (D)
What should you do to comply with good amateur practice when choosing a frequency for HF PSK operation?
A. Call CQ in Morse code before attempting to establish a contact in PSK
B. Select a frequency in the upper end of the phone band
C. Select a frequency in the lower end of the phone band
D. Follow generally accepted band plans for PSK operation

Each of the actions listed in answers A, B, and C is individually bad operating practice so they are incorrect choices. Therefore, the correct answer is **D** since it is a correct statement.

G2B12 (A)
What is a practical way to avoid harmful interference when selecting a frequency to call CQ using phone?
A. Ask if the frequency is in use, say your callsign, and listen for a response
B. Keep your CQ to less than 2 minutes in length to avoid interference to contacts that may be in progress
C. Listen for 2 minutes before calling CQ to avoid interference to contacts that may be in progress
D. Call CQ at low power first and if there is no indication of interference, increase power as necessary

Each of the actions listed in answers B, C, and D is individually bad operating practice or silly distractions so they are incorrect choices. Therefore, the correct answer is **A** since it is the correct operating practice.

G2B13 (C)
What is a practical way to avoid harmful interference when calling CQ using Morse code or CW?
A. Send the letter "V" 12 times and then listen for a response
B. Keep your CQ to less than 2 minutes in length to avoid interference with contacts already in progress
C. Send "QRL? de" followed by your callsign and listen for a response
D. Call CQ at low power first; if there is no indication of interference then increase power as necessary

Each of the actions listed in answers A, B, and D is individually bad operating practice or silly distractions so they are incorrect choices. Therefore, the correct answer is **C** since it is the correct operating practice.

G2C01 (C) [97.403]
When normal communications systems are not available, what means may an amateur station use to provide essential communications when there is an immediate threat to the safety of human life or the protection of property?
A. Only transmissions sent on internationally recognized emergency channels
B. Any means, but only to RACES recognized emergency stations
C. Any means of radiocommunication at its disposal
D. Only those means of radiocommunication for which the station is licensed

The Part 97 rules state that no "provision of these rules prevents the use by an amateur station of any means of radiocommunication at its disposal to provide essential communication needs in connection with the immediate safety of human life and immediate protection of property when normal communication systems are not available." This makes Answer **C** the correct choice to answer this question. The other choices are not consistent with the regulations.

```
G2C02 (A) [97.407(a)]
Who may be the control operator of an amateur station transmitting in RACES to
assist relief operations during a disaster?
A. Only a person holding an FCC issued amateur operator license
B. Only a RACES net control operator
C. Only official emergency stations may transmit during a disaster
D. Any control operator when normal communication systems are operational
```

The transmission rules for RACES in Part 97 state that no "station may transmit in RACES unless it is an FCC-licensed primary, club, or military recreation station and it is certified by a civil defense organization as registered with that organization, or it is an FCC-licensed RACES station. No person may be the control operator of a RACES station, or may be the control operator of an amateur station transmitting in RACES unless that person holds a FCC-issued amateur operator license and is certified by a civil defense organization as enrolled in that organization." As can be seen in the regulations, the control operator needs to have a valid amateur license so Answer **A** meets the regulations. Be careful with Answer D because it looks like it might fit but it is not phrased to match the regulations. Answers B and C are just to distract you.

```
G2C03 (D) [97.407(b)]
When may the FCC restrict normal frequency operations of amateur stations
participating in RACES?
A. When they declare a temporary state of communication emergency
B. When they seize your equipment for use in disaster communications
C. Only when all amateur stations are instructed to stop transmitting
D. When the President's War Emergency Powers have been invoked
```

Looking again to Part 97, we see that the RACES restrictions occur in the "event of an emergency which necessitates the invoking of the President's War Emergency Powers...." This specific emergent is the one mentioned in Answer **D** so it is the correct choice. The other choices are not covered here so they are incorrect.

```
G2C04 (C) [97.405(b)]
When is an amateur station prevented from using any means at its disposal to
assist another station in distress?
A. Only when transmitting in RACES
B. Only when authorized by the FCC rule
C. Never
D. Only on authorized HF frequencies
```

Based on the Part 97 regulation listed above, we should be able to spot Answer **C** as the correct choice – never. The other choices do not match the regulations so the are incorrect.

```
G2C05 (B) [97.403]
What type of transmission would a control operator be making when transmitting
out of the amateur band without station identification during a life
threatening emergency?
A. A prohibited transmission
B. An unidentified transmission
C. A third party communication
D. An auxiliary transmission
```

This transmission is not, strictly, prohibited if it is an emergency so Answer A is not a correct choice. It is not a third party transmission or an auxiliary transmission so answers C and D are incorrect. However, it is unidentified so Answer **B** is the correct choice.

G2C07 (B)
What is the first thing you should do if you are communicating with another amateur station and hear a station in distress break in?
A. Continue your communication because you were on frequency first
B. Acknowledge the station in distress and determine what assistance may be needed
C. Change to a different frequency
D. Immediately cease all transmissions

If we are to fulfill the goal of the amateur service to be a national resource in times of distress, and if we exercise a bit of common sense, we arrive at the conclusion that answer **B** is the best choice. Answers A and C will not help the station in distress. Answer D may sound correct but then how could you help?

G2C08 (C) [97.405(b)]
When are you prohibited from helping a station in distress?
A. When that station is not transmitting on amateur frequencies
B. When the station in distress offers no call sign
C. You are never prohibited from helping any station in distress
D. When the station is not another amateur station

Basically the rule is that operators using the amateur service can do whatever is necessary to assist when life and property are at risk. Therefore, you are never prevented from being a help and answer **C** is the right choice. All other choices are irrelevant because they restrict the general rule to be a help.

G2C09 (B) [97.111(a)(2)]
What type of transmissions may an amateur station make during a disaster?
A. Only transmissions when RACES net is activated
B. Transmissions necessary to meet essential communications needs and to facilitate relief actions
C. Only transmissions from an official emergency station
D. Only one-way communications

In Part 97, when discussing two-way communications, the FCC states that "Transmissions necessary to exchange messages with a station in another FCC-regulated service while providing emergency communications" are permitted. This makes Answer **B** the choice that meets the regulations. The other choices do not match the regulations.

G2C10 (C)
Which emission mode must be used to obtain assistance during a disaster?
A. Only SSB
B. Only SSB and CW
C. Any mode
D. Only CW

Based on what we have reviewed of the Part 97 regulations, you should be able to spot the right answer as Answer **C**. Any other choice is a restriction not found in the regulations so it is a wrong choice.

G2C11 (B)
What information should be given to a station answering a distress transmission?
A. The ITU region and grid square locator of the emergency
B. The location and nature of the emergency
C. The time that the emergency occurred and the local weather
D. The name of the local emergency coordinator

The right answer here is the obvious one: the location and nature of the emergency are needed to properly summon help. This makes answer **B** the right choice. Answer C might seem like good information but it really might not be as useful as the information in answer B so that remains the best choice. The other choices are silly distractions.

G2C12 (A)
What frequency should be used to send a distress call?
A. Whatever frequency has the best chance of communicating the distress message
B. 3873 kHz at night or 7285 kHz during the day
C. Only frequencies that are within your operating privileges
D. Only frequencies used by police, fire or emergency medical services

This is another statement of the basic rule for emergencies. At those times, you can use whatever frequency you need to communicate. This makes answer **A** the right choice for this question. The other choices would place restrictions on you that are not really there so they represent distractions to you.

G2D01 (A)
What is the Amateur Auxiliary to the FCC?
A. Amateur volunteers who are formally enlisted to monitor the airwaves for rules violations
B. Amateur volunteers who conduct amateur licensing examinations
C. Amateur volunteers who conduct frequency coordination for amateur VHF repeaters
D. Amateur volunteers who use their station equipment to help civil defense organizations in times of emergency

The Amateur Auxiliary is composed of amateurs who assist the FCC with regulating the Amateur Service so the correct answer is choice **A**. The other functions are the responsibility of other groups.

G2D02 (B)
What are the objectives of the Amateur Auxiliary?
A. To conduct efficient and orderly amateur licensing examinations
B. To encourage amateur self-regulation and compliance with the rules
C. To coordinate repeaters for efficient and orderly spectrum usage
D. To provide emergency and public safety communications

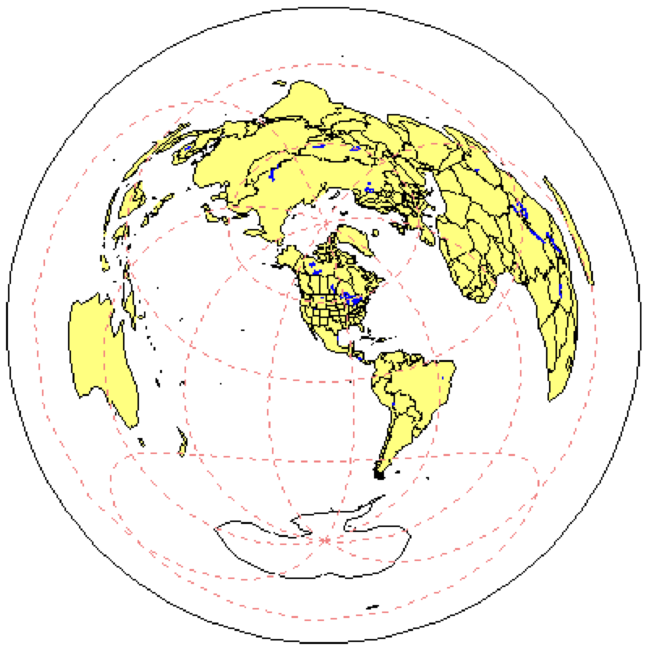
The correct choice is answer **B** – it is part of the self-regulation of the Amateur Service. Answer A may sound reasonable but that is the domain of the Volunteer Examiners. Answer C may sound good as well but it is wrong. Answer D is to distract you.

G2D03 (B)
What skills learned during "Fox Hunts" are of help to the Amateur Auxiliary?
A. Identification of out of band operation
B. Direction-finding skills used to locate stations violating FCC Rules
C. Identification of different call signs
D. Hunters have an opportunity to transmit on non-amateur frequencies

Radio fox hunts have nothing to do with animals despite the name. Rather, it is a direction-finding skill so the correct answer is **B**. Answer D is to make you smile while answers A and C are irrelevant.

G2D04 (B)
What is an azimuthal projection map?
A. A world map projection centered on the North Pole
B. A world map projection centered on a particular location
C. A world map that shows the angle at which an amateur satellite crosses the equator
D. A world map that shows the number of degrees longitude that an amateur satellite appears to move westward at the equator with each orbit

The definition of an azimuthal map is the one given in answer **B**. All of the other answers are there as distractions. The graphic illustrates an azimuthal map centered on Las Cruces, New Mexico.

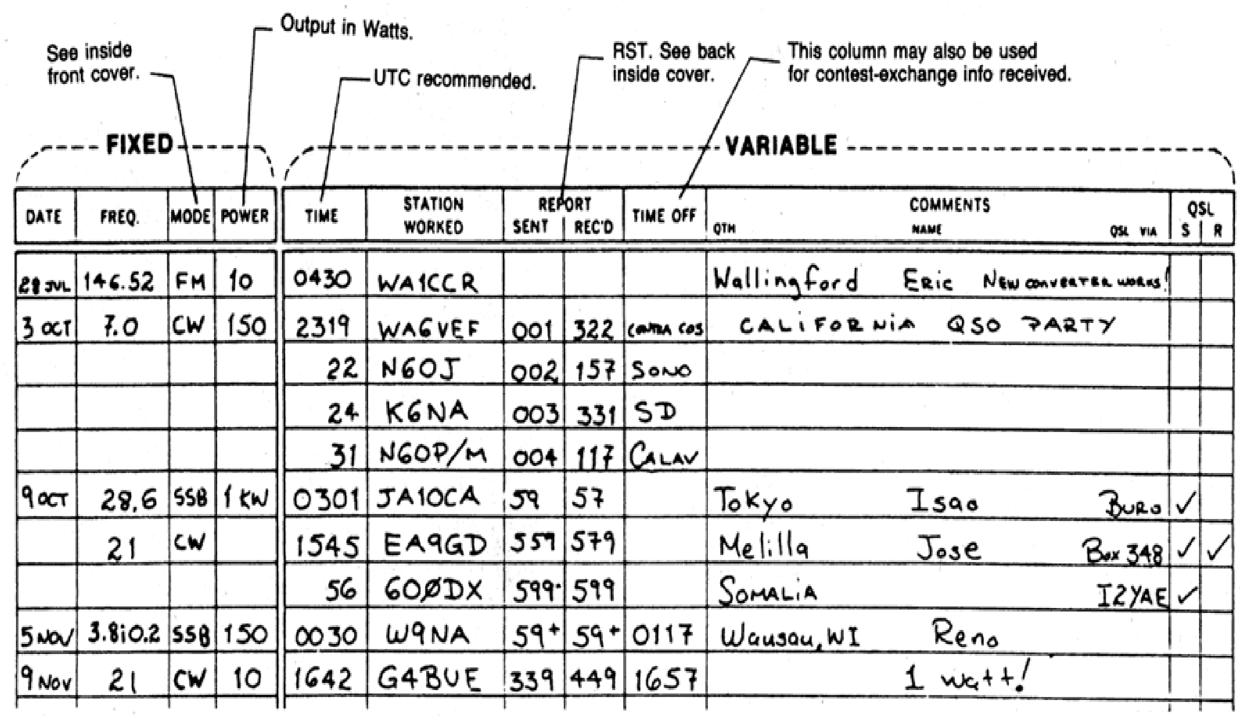


G2D05 (A)
What is the most useful type of map to use when orienting a directional HF antenna toward a distant station?
A. Azimuthal projection
B. Mercator projection
C. Polar projection
D. Stereographic projection

If you were to lay each of these map types next to each other, only the azimuthal map in answer **A** would give undistorted pointing directions no matter which way we moved around the azimuth circle so it is the best choice. All of the other map types would generally give distorted pointing information.

G2D06 (C)
How is a directional antenna pointed when making a "long-path" contact with another station?
A. Toward the rising sun
B. Along the Gray Line
C. 180 degrees from its short-path heading
D. Toward the North

By looking at the shape and geometry of a sphere we can see that short paths and long paths are points in directions 180 degrees apart so the correct answer is **C**. The others will not lead to connected paths of minimum length so they are wrong.



DATE	FREQ.	MODE	POWER	TIME	STATION WORKED	REPORT SENT	REPORT REC'D	TIME OFF	COMMENTS (QTH / NAME / QSL VIA)	QSL S	QSL R
28 JUL	146.52	FM	10	0430	WA1CCR				Wallingford Eric New converter works!		
3 OCT	7.0	CW	150	2319	WA6VEF	001	322	CONTRA COS	CALIFORNIA QSO PARTY		
				22	N6OJ	002	157	SONO			
				24	K6NA	003	331	SD			
				31	N6OP/M	004	117	CALAV			
9 OCT	28.6	SSB	1 KW	0301	JA1OCA	59	57		Tokyo Isao Buro	✓	
	21	CW		1545	EA9GD	559	579		Melilla Jose Box 348	✓	✓
				56	6OØDX	599	599		Somalia I2YAE	✓	
5 NOV	3.810.2	SSB	150	0030	W9NA	59+	59+	0117	Wausau, WI Reno		
9 NOV	21	CW	10	1642	G4BUE	339	449	1657	1 watt!		

G2D07 (B) [97.103b]
Which of the following information must a licensee retain as part of their station records?
A. The call sign of other amateurs operating your station
B. Antenna gain calculations or manufacturer's data for antennas used on 60 meters
C. A record of all contacts made with stations in foreign countries
D. A copy of all third party messages sent through your station

The FCC says that the for all transmissions "station licensee must designate the station control operator. The FCC will presume that the station licensee is also the control operator, unless documentation to the contrary is in the station records." This would seem to make Answer A the right choice. However, the question asks for information that must be kept. Here, the relevant portion of Part 97 that we saw earlier states that station licensees "using other antennas must maintain in their station records either manufacturer data on the antenna gain or calculations of the antenna gain." Therefore, Answer **B** is the better choice because it covers required information and not optional information. The other information is of general operating interest but not in the sense that part 97 is interested in.

G2D08 (D)
Why do many amateurs keep a log even though the FCC doesn't require it?
A. The ITU requires a log of all international contacts
B. The ITU requires a log of all international third party traffic
C. The log provides evidence of operation needed to renew a license without retest
D. To help with a reply if the FCC requests information on who was control operator of your station at a given date and time

The ITU does not have jurisdiction over your station so Answers A and B are incorrect. Answer C is not part of the licensing procedure so it is also incorrect. Therefore, the best choice is answer **D** as we saw in the previous question.

G2D09 (D)
What information is traditionally contained in a station log?
A. Date and time of contact
B. Band and/or frequency of the contact
C. Call sign of station contacted and the signal report given
D. All of these choices are correct

If you keep a station log like the one shown in the graphic, then you will probably wish to keep a record of each of the items in answers A through C for every QSO so the best choice is answer **D**.

G2D10 (B)
What is QRP operation?
A. Remote Piloted Model control
B. Low power transmit operation, typically about 5 watts
C. Transmission using Quick Response Protocol
D. Traffic Relay Procedure net operation

The correct choice corresponds to Answer **B** because QRP is used to designate low-power operations. The other choices are silly distractions.

G2D11 (C)
Which HF antenna would be the best to use for minimizing interference?
A. A bi-directional antenna
B. An isotropic antenna
C. A unidirectional antenna
D. An omnidirectional antenna

To minimize interference, we wish to tightly control the directional pointing of the emissions from the antenna. In other words, we want a unidirectional antenna as given in answer **C**. Answer A will help to the sides but not in the back direction so this is not a good choice. Answer B is an antenna that radiates equally-well in all directions so this is not a good antenna choice to answer the question. The omnidirectional antenna of answer D will transmit in all directions so this will not help with the interference.

G2D12 (A) [97.303s]
Which of the following is required by the FCC rules when operating in the 60 meter band?

A. If you are using other than a dipole antenna, you must keep a record of the gain of your antenna
B. You must keep a log of the date, time, frequency, power level and stations worked
C. You must keep a log of all third party traffic
D. You must keep a log of the manufacturer of your equipment and the antenna used

We saw restrictions on 60-meters earlier. As we just saw above, the relevant portion of Part 97 for this question states that station licensees “using other antennas must maintain in their station records either manufacturer data on the antenna gain or calculations of the antenna gain.” This makes Answer **A** the one that corresponds to the regulations. Be careful with Answer D because it is similar but not exactly what is required. The other two choices are to distract you.

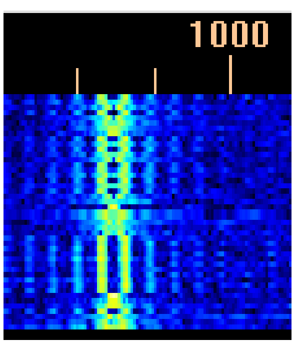
G2E01 (D)
Which mode should be selected when using a SSB transmitter with an Audio Frequency Shift Keying (AFSK) RTTY signal?

A. USB
B. DSB
C. CW
D. LSB

This is an operational protocol question: you need to know that the correct response is LSB as in Answer **D**.

G2E02 (A)
How many data bits are sent in a single PSK31 character?

A. The number varies
B. 5
C. 7
D. 8



While ASCII and Baudot coding use a fixed number of bits to encode each character, PSK31 uses a variable number of bits to encode each character. This is the coding philosophy used in Morse code. Therefore, answer **A** is the correct choice. Answer B corresponds to Baudot code while answer C corresponds to ASCII. Answer D corresponds to extended ASCII coding.
The graphic shows how PSK31 appears on the band.

G2E03 (C)
What part of a data packet contains the routing and handling information?

A. Directory
B. Preamble
C. Header
D. Footer

The header of a packet contains the routing and handling information so answer **C** is the right choice to answer this question. The choices of answers A, B, and D are not part of the normal packet structure nomenclature so they are just here to provide distraction choices to answer this question.

```
G2E04 (B)
Which of the following 20 meter band segments is most often used for most data
transmissions?
A. 14.000 - 14.050 MHz
B. 14.070 - 14.100 MHz
C. 14.150 - 14.225 MHz
D. 14.275 - 14.350 MHz
```

This is another radio practice question that you will be more familiar with as you gain operating experience across the HF bands. By looking at the band plan, we see that the correct answer is **B** – in the segment just above the lower edge of the band.

```
G2E05 (C)
Which of the following describes Baudot RTTY?
A. 7-bit code, with start, stop and parity bits
B. Utilizes error detection and correction
C. 5-bit code, with additional start and stop bits
D. Two major operating modes are SELCAL and LISTEN
```

You need to remember that Baudot codes are 5-bit codes so Answer **C** is the right choice. Answer A is ASCII coding. Answers B and D are incorrect for baudot codes.

```
G2E06 (B)
What is the most common frequency shift for RTTY emissions in the amateur HF
bands?
A. 85 Hz
B. 170 Hz
C. 425 Hz
D. 850 Hz
```

Back to a radio practice question here. You need to remember that by standard practice, the correct answer is 170 Hz or choice **B**. The others are just to distract you.

```
G2E07 (B)
What does the abbreviation "RTTY" stand for?
A. "Returning To You", meaning "your turn to transmit"
B. Radio-Teletype
C. A general call to all digital stations
D. Repeater Transmission Type
```

You need to remember that RTTY (pronounced “ritty”) is Radio Teletype so Answer **B** is the correct choice. Answer C corresponds “CQ”. The others are silly distractions.

```
G2E08 (A)
What segment of the 80 meter band is most commonly used for data
transmissions?
A. 3570 - 3600 kHz
B. 3500 - 3525 kHz
C. 3700 - 3750 kHz
D. 3775 - 3825 kHz
```

This is another radio practice question that you will be more familiar with as you gain operating experience across the HF bands. Generally, the data segment of the band is near the low-frequency end – but not at the lowest frequency segment. It is usually in the segment just above the low frequency segment. By looking at the band plan, we see that the correct answer is **A**. The other answers are to see if you have a band plan near by to refer to.

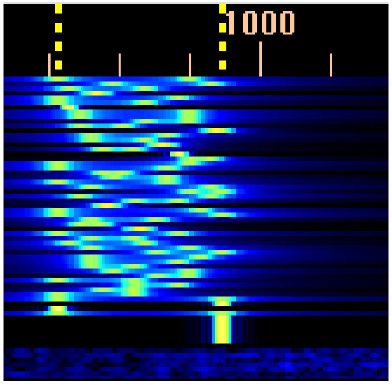
```
G2E09 (D)
Where are PSK signals generally found on the 20 meter band?
A. In the low end of the phone band
B. In the high end of the phone band
C. In the weak signal portion of the band
D. Around 14.070 MHz
```

PSK is a data transmission like what we had in the earlier question about data transmissions on 20 meters. A popular place to find PSK transmissions is right around 14.070 MHz so Answer **D** is the right choice. The others are not consistent with good operating practice.

```
G2E10 (D)
What is a major advantage of MFSK16 compared to other digital modes?
A. It is much higher speed than RTTY
B. It is much narrower bandwidth than most digital modes
C. It has built-in error correction
D. It offers good performance in weak signal environment without error
      correction
```

In an operational sense, the best thing about MFSK16 is the weak signal performance. It is a lot of fun! This makes answer **D** the best choice. Because there are many digital modes, the choices in Answers A, B, and C are not specific enough to make any definitive statement so they are not as good a choice.

```
G2E11 (B)
What does the abbreviation "MFSK" stand for?
A. Manual Frequency Shift Keying
B. Multi (or Multiple) Frequency Shift Keying
C. Manual Frequency Sideband Keying
D. Multi (or Multiple) Frequency Sideband Keying
```



The abbreviation "MFSK" stands for Multi (or Multiple) Frequency Shift Keying. A picture of the mode on the band is shown in the graphic. Answer **B** contains the right decoding of the abbreviation. Be careful during the test because the others may look close.

G2F01 (D)
Which of the following describes full break-in telegraphy (QSK)?
A. Breaking stations send the Morse code prosign BK
B. Automatic keyers are used to send Morse code instead of hand keys
C. An operator must activate a manual send/receive switch before and after every transmission
D. Incoming signals are received between transmitted code character elements

As you gain more experience with HF rigs, you will recognize the definition in answer **D** as the one for full break-in telegraphy. Answer C would be operationally very slow and achieves the opposite effect from the objectives of full break-in telegraphy. Answers A and B might sound reasonable but they do not fit the definition.

G2F02 (A)
What should you do if a CW station sends "QRS" when using Morse code?
A. Send slower
B. Change frequency
C. Increase your power
D. Repeat everything twice.

"QRS" is the Q signal dealing with CW transmission speed. In this case, it means send more slowly so Answer **A** is the correct choice. Answer B corresponds to "QSY". Answer C corresponds to "QRO" (the opposite of "QRP"). Answer D is to make you smile.

G2F03 (C)
What does it mean when a CW operator sends "KN" at the end of a transmission?
A. Listening for novice stations
B. Operating full break-in
C. Listening only for a specific station or stations
D. Closing station now

"KN" is a procedural signal inviting specific stations to transmit. This makes Answer **C** the correct choice. Answer D is "CL". As we saw above, operating full break-in is "QSK". Answer A is to make you smile.

G2F04 (D)
What does it mean when a CW operator sends "CL" at the end of a transmission?
A. Keep frequency clear
B. Operating full break-in
C. Listening only for a specific station or stations
D. Closing station

As we just saw above, "CL" means closing the station so Answer **D** is the correct choice. Answer C corresponds to "KN". Answer B corresponds to "QSK". Answer A is to distract you.

G2F05 (B)
What is the best speed to use answering a CQ in Morse Code?
A. The speed at which you are most comfortable copying
B. The speed at which the CQ was sent
C. A slow speed until contact is established
D. 5 wpm, as all operators licensed to operate CW can copy this speed

This is a common sense question. The best speed to answer is the same speed at which the CQ was sent (if you are able to). This makes Answer **B** the correct choice. Answer C is not good for proficient operators. Answer D is not a regulation. Answer A might be good for you but not the sender so it is not as good a choice as Answer B.

```
G2F06 (D)
What does the term "zero beat" mean in CW operation?
A. Matching the speed of the transmitting station
B. Operating split to avoid interference on frequency
C. Sending without error
D. Matching the frequency of the transmitting station
```

The term “zero beat” means matching the frequency of the transmitting station so Answer **B** is the correct answer. This occurs because if the frequencies are not matched, there will be a beating of the signals that can be heard. The other choices do not have anything to do with this term.

```
G2FO7 (A)
When sending CW, what does a "C" mean when added to the RST report?
A. Chirpy or unstable signal
B. Report was read from S meter reading rather than estimated
C. 100 percent copy
D. Key clicks
```

The RST report has three components: readability, signal strength, and tone. There are times when there are other common problems that need to be noted. The notation “C” means signal chirp is present. This makes Answer **A** the correct choice. Answer D corresponds to a “K”. Answer B is nice but not relevant. Answer C is often reported but it is not part of the RST report.

```
G2F08 (C)
What prosign is sent using CW to indicate the end of a formal message?
A. SK
B. BK
C. AR
D. KN
```

The correct prosign (procedural sign) for the end of a formal message is “AR” so Answer **C** is the correct choice. “SK” means end of contact. “BK” means BacK to you. We saw above that “KN” is for specific stations to transmit.

```
G2F09 (C)
What does the Q signal "QSL" mean when operating CW?
A. Send slower
B. We have already confirmed by card
C. I acknowledge receipt
D. We have worked before
```

The Q signal “QSL” means “I copy” or “I acknowledge receipt” so answer **C** is the correct choice. We saw above that “QRS” means send slower. Be careful with answer B because you may soon be collecting QSL cards but that is not implied by “QSL” during transmission. Answer D is nice but not a Q signal.

```
G2F10 (B)
What does the Q signal "QRQ" mean when operating CW?
A. Slow down
B. Send faster
C. Zero beat my signal
D. Quitting operation
```

“QRQ” is the opposite sense of “QRS” and it implies that you want a quicker transmission so Answer B is the correct choice. Answer A is “QRS”. Answer D is “CL”. Answer C is not a signal.

```
G2F11 (D)
What does the Q signal "QRV" mean when operating CW?
A. You are sending too fast
B. There is interference on the frequency
C. I am quitting for the day
D. I am ready to receive messages
```

The Q signal “QRV” means that you are ready for messages so Answer **D** is the correct choice. Answer A would be used with “QRS”. Answer B is “QRM”. Answer C is “CL”.

Subelement G3 - Radio Wave Propagation

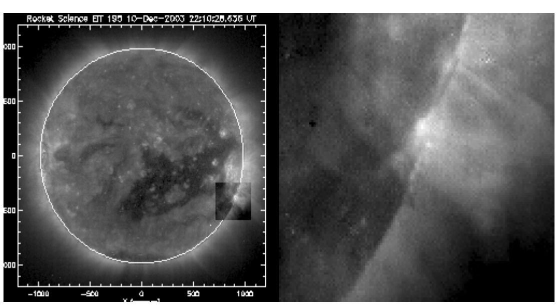
G3A01 (A)
What can be done at an amateur station to continue communications during a sudden ionospheric disturbance?
A. Try a higher frequency
B. Try the other sideband
C. Try a different antenna polarization
D. Try a different frequency shift

The correct answer is **A**. Moving to a higher frequency is your best bet for getting beyond the ionospheric interference that affects lower frequencies more than higher frequencies. Since the disturbance depends on frequency, changing the sideband as in answer B or the polarization as in answer C will not move you to a different frequency - the carrier would still stay the same. The frequency shift in answer D is the right idea but the frequency shifts of most rigs are too small of a change to make any effect and will increase your transmission bandwidth – a bad idea. All that’s left is to QSY!

G3A02 (B)
What effect does a Sudden Ionospheric Disturbance (SID) have on the daytime ionospheric propagation of HF radio waves?
A. It disrupts higher-latitude paths more than lower-latitude paths
B. It disrupts signals on lower frequencies more than those on higher frequencies
C. It disrupts communications via satellite more than direct communications
D. None, because only areas on the night side of the Earth are affected

The correct answer is **B**. As in the previous question, lower frequencies are affected more than higher frequencies by ionospheric interference. Answer A looks close but that is not a day-time effect – it can happen at any time of the day. Answer C is not correct since the disturbance affects any communications interacting with the ionosphere so if the communications are on the ground or from space, it does not matter. Answer D is silly since the night side of the earth faces away from the direction from which the charged particles from the sun are coming.

G3A03 (C)
How long does it take the increased ultraviolet and X-ray radiation from solar flares to affect radio-wave propagation on the Earth?
A. 28 days
B. Several hours depending on the position of the Earth in its orbit
C. Approximately 8 minutes
D. 20 to 40 hours after the radiation reaches the Earth



Solar flares, like the one in the figure, eject particles and energetic photons from the sun. This question deals with different types of photon radiation which travel at the speed of light. The light travel time from the sun to the earth is 8 minutes so the only correct answer can be **C**. The rest are there to distract you. Answer D may sound familiar because it is the time for charged particles emitted by the sun to reach the earth but we are dealing with electromagnetic radiation here so we go with answer C.

```
G3A04 (B)
What is measured by the solar flux index?
A. The density of the sun's magnetic field
B. The radio energy emitted by the sun
C. The number of sunspots on the side of the sun facing the Earth
D. A measure of the tilt of the Earth's ionosphere on the side toward the sun
```

The sun emits electromagnetic radiation (light and radio waves) and charged particles. A flux is a measurement of something emitted. Therefore, the correct answer is **B**. Answers A and C are important in the solar flare process but they are not fluxes so they are distractions here. Answer D is irrelevant to the flux measurement so it is also wrong.

```
G3A05 (D)
What is the solar-flux index?
A. A measure of the highest frequency that is useful for ionospheric
      propagation between two points on the Earth
B. A count of sunspots which is adjusted for solar emissions
C. Another name for the American sunspot number
D. A measure of solar activity at 10.7 cm
```

Answers A, B, and C are all measurements that can be made and are made by professionals. However, answer D is the definition of the solar flux index. It is a measurement of the sun at a specific frequency and so the correct answer is **D**.

```
G3A06 (D)
What is a geomagnetic disturbance?
A. A sudden drop in the solar-flux index
B. A shifting of the Earth's magnetic pole
C. Ripples in the ionosphere
D. A significant change in the Earth's magnetic field over a short period of
      time
```

The key here is the phrase “geomagnetic disturbance” in the question statement. That means the earth’s magnetic field. Answer **D** is the only one that deals with the earth’s magnetic field so it is the right one. Answer A would be good to know for propagation prediction but it is a distraction here. Answer B happens every few thousand years so don’t wait for it. Answer C is to distract you as well.

```
G3A07 (A)
Which latitudes have propagation paths that are more sensitive to geomagnetic
disturbances?
A. Those greater than 45 degrees North or South latitude
B. Those between 5 and 45 degrees North or South latitude
C. Those at or very near to the equator
D. All paths are affected equally
```

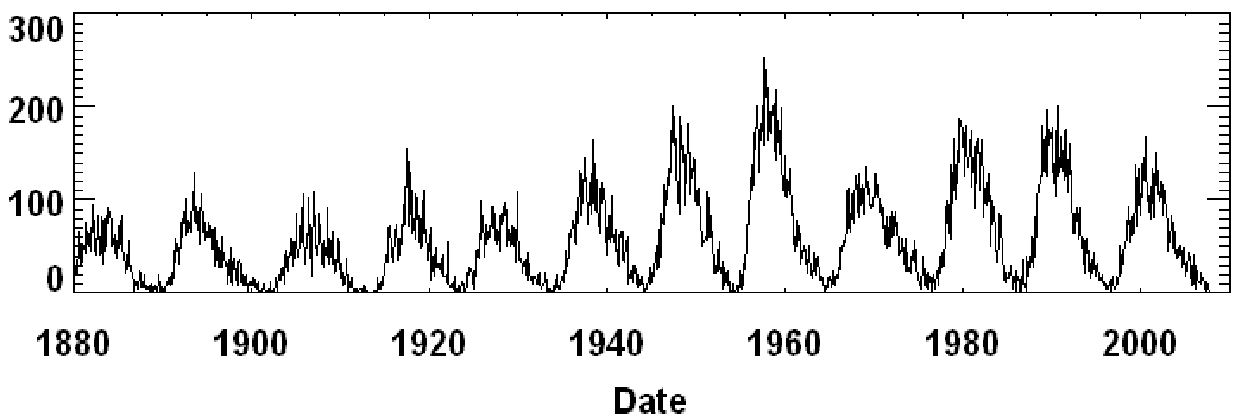
Geomagnetic disturbances affect propagation closest to the earth’s magnetic poles. Therefore, the high-latitude locations (greater than 45 degrees) will be affected most and the correct answer is **A**. Mid-latitudes are affected less so answer B is wrong. The equatorial region is closest to midway between the magnetic poles so it is affected the least making answer C also wrong. Answer D is wrong since the effects depend upon latitude.

G3A08 (B)
What can be an effect of a geomagnetic storm on radio-wave propagation?
A. Improved high-latitude HF propagation
B. Degraded high-latitude HF propagation
C. Improved ground-wave propagation
D. Improved chances of UHF ducting

So far, we have seen that geomagnetic storms make radio propagation worse. Therefore answers A, C, and D are wrong since they imply improved communications in some way. The only correct answer is **B** since it is the only one implying degraded communications and it agrees with the answer to the previous question.

G3A09 (C)
What is the effect on radio communications when sunspot numbers are high?
A. High-frequency radio signals become weak and distorted
B. Frequencies above 300 MHz become usable for long-distance communication
C. Long-distance communication in the upper HF and lower VHF range is enhanced
D. Long-distance communication in the upper HF and lower VHF range is diminished

Since sunspots are associated with activity on the sun, high sunspot numbers are correlated with high numbers of flares and other disturbances that will affect HF and VHF propagation on the earth. This makes answer **C** the correct choice to answer the question. The effects on the ionosphere do not cause absorption so answer A is incorrect. Answer D is not specific enough so it is not as good a choice as answer C. Answer B is in the UHF region and not the VHF region so this is not a correct choice either.



G3A10 (A)
What is the sunspot number?
A. A measure of solar activity based on counting sunspots and sunspot groups
B. A 3 digit identifier which is used to track individual sunspots
C. A measure of the radio flux from the sun measured at 10.7 cm
D. A measure of the sunspot count based on radio flux measurements

The sunspot number changes every day as they grow and decay on the sun's surface and as the sun rotates. The correct definition is given in answer **A** since the sunspot number is a daily index. This index value is available at http://www.spaceweather.com, among other sites listing the current value. The other choices are incorrect because they do not account the daily variation. The sun spot numbers for the past 120+ years are shown in the graphic.

```
G3A11 (D)
How long is the typical sunspot cycle?
A. Approximately 8 minutes
B. Between 20 and 40 hours
C. Approximately 28 days
D. Approximately 11 years
```

As can be seen by the time between the peaks in the previous figure, the sunspot cycle is approximately 11 years in duration. This makes answer **D** the correct choice. Be careful with answers A and B because they contain travel times for various solar emissions but they are not correct descriptions of the cycle. Answer C is incorrect because it is the sun's rotation period (solar day).

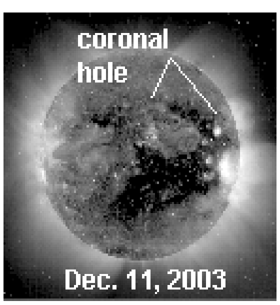
```
G3A12 (B)
What is the K-index?
A. An index of the relative position of sunspots on the surface of the sun
B. A measure of the short term stability of the Earth's magnetic field
C. A measure of the stability of the sun's magnetic field
D. An index of solar radio flux measured at Boulder, Colorado
```

There are two indices of geomagnetic activity so we have two questions about them. The first is the K-index which measures the current geomagnetic activity. Of the choices given, answer **B** is the best choice because the K-index is a measure of geomagnetic activity over the past three hours. Answers A and B cannot be correct because they deal with other aspects of the sun's surface. Answer D sounds good but it has nothing to do with the A-index.

```
G3A13 (C)
What is the A-index?
A. An index of the relative position of sunspots on the surface of the sun
B. The amount of polarization of the sun's electric field
C. An indicator of the long term stability of the Earth's geomagnetic field
D. An index of solar radio flux measured at Boulder, Colorado
```

This question is about the second geomagnetic index, the A-index. The A-index is the daily average based on the K-index and has a range of 0 through 400. This makes answer **C** the correct choice. Answers A and B cannot be correct because they deal with other aspects of the sun's surface. Answer D sounds good but it has nothing to do with the A-index.

```
G3A14 (B)
How are radio communications usually affected by the charged particles that
reach the Earth from solar coronal holes?
A. HF communications are improved
B. HF communications are disturbed
C. VHF/UHF ducting is improved
D. VHF/UHF ducting is disturbed
```



Based on a look at the answers, you can suspect that coronal hole activity is associated with the sun emitting charged particles. The charged particles interact with the earth's magnetic field and cause disruptions to HF communications which makes answer **B** the right choice to answer this question. Answer A is incorrect because the HF is not improved. Ducting is a weather effect in the troposphere so answers C and D are incorrect.

G3A15 (D)
How long does it take charged particles from Coronal Mass Ejections to affect radio-wave propagation on the Earth?
A. 28 days
B. 14 days
C. The effect is instantaneous
D. 20 to 40 hours

Even moving at the speed of light, the radiation takes at least 8 minutes to reach us so Answer C is incorrect. Particles travel slower than the speed of light so it takes longer than 8 minutes which makes answers A and B incorrect as well. The correct choice is the 20 to 40 hours found in answer **D**.

G3A16 (A)
What is a possible benefit to radio communications resulting from periods of high geomagnetic activity?
A. Aurora that can reflect VHF signals
B. Higher signal strength for HF signals passing through the polar regions
C. Improved HF long path propagation
D. Reduced long delayed echoes

Periods of high geomagnetic activity are associated with visible aurora so answer **A** is the right choice. By now, you should recognize that HF communications are frequently disrupted at these times so answers B and C are incorrect. Answer D is not an effect so this is not a good choice.

G3A17 (D)
At what point in the solar cycle does the 20 meter band usually support worldwide propagation during daylight hours?
A. At the summer solstice
B. Only at the maximum point of the solar cycle
C. Only at the minimum point of the solar cycle
D. At any point in the solar cycle

Again, this is an operating experience question. The 20-meter is generally "open" all day and at any point in the solar cycle. Therefore, the correct answer is **D**. The other choices are there to distract you.

G3A18 (C)
If the HF radio-wave propagation (skip) is generally good on the 24-MHz and 28-MHz bands for several days, when might you expect a similar condition to occur?
A. 7 days later
B. 14 days later
C. 28 days later
D. 90 days later

Good conditions for several days would be caused by solar activity. The sun rotates with a 28-day "day". Therefore, we would expect good conditions one solar day later so the correct answer is **C**. The other answers are there to distract you.

G3A19 (D)
Which frequencies are least reliable for long distance communications during periods of low solar activity?
A. Frequencies below 3.5 MHz
B. Frequencies near 3.5 MHz
C. Frequencies at or above 10 MHz
D. Frequencies above 20 MHz

This is a question that will make more sense to you once you have good operating experience on the HF bands. Generally, during low solar activity periods, the bands are pretty dead on a regular basis above 20 meters. Another way of saying that is above 14 MHz. Since all of the choices except D are below the 20-meter band and the question is looking for the least reliable communications, the correct answer is **D**. The other frequencies will be able to sustain communications even with low solar activity.

G3B01 (B)
Which band should offer the best chance for a successful contact if the maximum usable frequency (MUF) between the two stations is 22 MHz?
A. 10 meters
B. 15 meters
C. 20 meters
D. 40 meters

The MUF is defined for radio communications in general and not just on the amateur bands. To answer the question, we need to pick an amateur band below the MUF and not just any frequency. Here we need to review our frequency band designations:

2 meters – 144 MHz	20 meters – 14 MHz
6 meters – 50 MHz	40 meters – 7 MHz
10 meters – 28 MHz	75 meters - 3.9 MHz
15 meters – 21 MHz	80 meters - 3.5 MHz

Since the MUF is at 22 MHz, we will try to operate just below it. The 15-meter band is just below the MUF so the correct answer is **B**. 10 meters is above the MUF so answer A is wrong. Answers C and D are below 15 meters so 15 meters is the best answer of the choices.

G3B02 (C)
Which band should offer the best chance for a successful contact if the maximum usable frequency (MUF) between the two stations is 16 MHz?
A. 80 meters
B. 40 meters
C. 20 meters
D. 2 meters

We use the same frequency and band relationship used in the previous question. Since the MUF is at 16 MHz, we choose **C** or 20 meters as the best answer since 20 meters or 14 MHz is just below the MUF. 2 meters is above the MUF so answer D is out. Answers A and B are below 20 meters so they are not as good a choice here.

```
G3B03 (A)
Which of the following guidelines should be selected for lowest attenuation
when transmitting on HF?
A. Select a frequency just below the MUF
B. Select a frequency just above the LUF
C. Select a frequency just below the critical frequency
D. Select a frequency just above the critical frequency
```

Based on what we just saw, picking frequencies just below the MUF is the best option among those given here so Answer **A** is the best choice. Answer B will cause attenuation on the signal. "Critical frequencies" are used in filters and other electronics so they are not correct choices here.

```
G3B04 (A)
What is a reliable way to determine if the maximum usable frequency (MUF) is
high enough to support 28-MHz propagation between your station and Western
Europe?
A. Listen for signals on a 28 MHz international beacon
B. Send a series of dots on the 28 MHz band and listen for echoes from your
      signal
C. Check the strength of TV signals from Western Europe
D. Listen to WWV propagation signals on the 28 MHz band
```

We can go back to our band designations here. 28 MHz is in the 10-meter band so we would listen for a 10-meter beacon frequency to determine if there is a band opening as in Answer **A**. Answer D sounds official but WWV does not operate in Europe so it is not a good choice. Answers B and C are silly distractions.

```
G3B05 (A)
What usually happens to radio waves with frequencies below the maximum usable
frequency (MUF) when they are sent into the ionosphere?
A. They are bent back to the Earth
B. They pass through the ionosphere
C. They are completely absorbed by the ionosphere
D. They are bent and trapped in the ionosphere to circle the Earth
```

Frequencies below the MUF are reflected back to the earth, frequencies above the MUF keep on going out to space. The correct answer is **A**. Answer B is for frequencies above the MUF. Answer C is more of a D-layer type of effect and usually only occurs much below the MUF. Answer D is rather humorous.

```
G3B06 (C)
What usually happens to radio waves with frequencies below the lowest usable
frequency (LUF)?
A. They are bent back to the Earth
B. They pass through the ionosphere
C. They are completely absorbed by the ionosphere
D. They are bent and trapped in the ionosphere to circle the Earth
```

Frequencies below the LUF are absorbed as in Answer **C**. Answers A and B deal with frequencies on either side of the MUF. Answer D is still humorous.

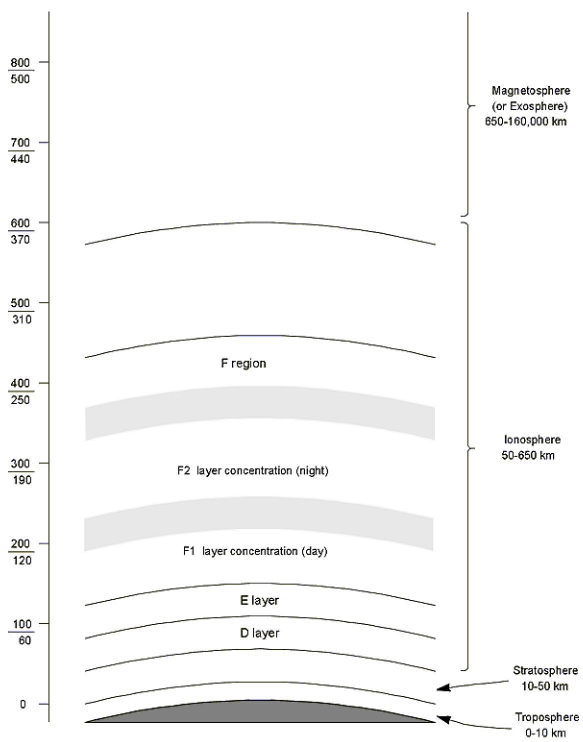
G3B07 (A)
What does LUF stand for?
A. The Lowest Usable Frequency for communications between two points
B. The Longest Universal Function for communications between two points
C. The Lowest Usable Frequency during a 24 hour period
D. The Longest Universal Function during a 24 hour period

As we have been indicating, LUF is the Lowest Usable Frequency so Answer **A** is the correct choice. Be careful when taking the test because the other choices look similar.

G3B08 (B)
What does MUF stand for?
A. The Minimum Usable Frequency for communications between two points
B. The Maximum Usable Frequency for communications between two points
C. The Minimum Usable Frequency during a 24 hour period
D. The Maximum Usable Frequency during a 24 hour period

The MUF is the Maximum Usable Frequency so Answer **B** is the correct choice. Be careful with the other choices because they look similar.

G3B09 (C)
What is the maximum distance along the Earth's surface that is normally covered in one hop using the F2 region?
A. 180 miles
B. 1,200 miles
C. 2,500 miles
D. 12,000 miles



Since the F2 region is the highest region of concern, and we use reflections to direct the signals back to the earth, the correct answer is **C** since it corresponds to the longest baseline. The choices for answer A and B correspond to lower atmosphere regions. Answer D is just to distract you.

G3B10 (B)
What is the maximum distance along the Earth's surface that is normally covered in one hop using the E region?
A. 180 miles
B. 1,200 miles
C. 2,500 miles
D. 12,000 miles

The E region is a lower region in the atmosphere than the F region but it is above the D region. Therefore, answer C is out since that answer goes with the F region. Since the E region is at a middle height, it produces a middle-length distance and the correct answer is **B**. Answer A is too short a path for the geometry. Answer D is to distract you.

G3B11 (A)
What happens to HF propagation when the lowest usable frequency (LUF) exceeds the maximum usable frequency (MUF)?
A. No HF radio frequency will support communications over the path
B. HF communications over the path are enhanced at the frequency where the LUF and MUF are the same
C. Double hop propagation along the path is more common
D. Propagation over the path on all HF frequencies is enhanced

By reasoning through the question statement, you should be able to see that the HF bands will be dead as far as the operator is concerned since no HF propagation will occur. This makes answer **A** the correct choice to answer the question. Answer B is incorrect so it is not a good choice. Answers C and D sound good but they are just technobabble.

G3B12 (D)
What factors affect the maximum usable frequency (MUF)?
A. Path distance and location
B. Time of day and season
C. Solar radiation and ionospheric disturbance
D. All of these choices are correct

Each of the choices given in answers A, B, and C are factors in determining the MUF. This makes answer **D** the best choice to answer the question.

G3B13 (D)
How might a sky-wave signal sound if it arrives at your receiver by both short path and long path propagation?
A. Periodic fading approximately every 10 seconds
B. Signal strength increased by 3 dB
C. The signal will be cancelled causing severe attenuation
D. A well-defined echo can be heard

In this case, you will hear the long-path signal as a time-delayed version of the short-path signal which makes answer **D** the right choice to answer the question. The distraction choices in answers A, B, and C are to see if you can be confused by technical-sounding answers.

G3B14 (A)
Which of the following is a good indicator of the possibility of sky-wave propagation on the 6 meter band?
A. Short hop sky-wave propagation on the 10 meter band
B. Long hop sky-wave propagation on the 10 meter band
C. Severe attenuation of signals on the 10 meter band
D. Long delayed echoes on the 10 meter band

This is a question that will make more sense with operating experience. A "short hop on 10 meters" is associated with a phenomenon known as "Sporadic E" propagation where the E-layer will support a much higher MUF for a short while. When this occurs, the MUF exceeds 50 MHz (6 meter band) so answer **A** is the right choice. Answers B, C, and D are to see if you understand how 6-meter and 10-meter propagation is related.

G3C01 (A)
Which of the following ionospheric layers is closest to the surface of the Earth?
A. The D layer
B. The E layer
C. The F1 layer
D. The F2 layer

If you go back to the previous graphic on atmospheric layers, you will see that the D layer is closest to the earth, then the E layer, and then the two F layers. From this, the D layer, or Answer **A**, is the correct response.

G3C02 (A)
When can the F2 region be expected to reach its maximum height at your location?
A. At noon during the summer
B. At midnight during the summer
C. At dusk in the spring and fall
D. At noon during the winter

The F region reacts to ultraviolet radiation from the sun. The maximum intensity of this radiation occurs when the sun is highest in the sky at your location which is at noon during the summer. Therefore, the correct answer is **A**. Be careful with answer D since it has the right time of the day – just the wrong season of the year. Answer B has the right season but just the opposite time of day. Answer C is to distract you.

G3C03 (C)
Why is the F2 region mainly responsible for the longest distance radio wave propagation?
A. Because it is the densest ionospheric layer
B. Because it does not absorb radio waves as much as other ionospheric regions
C. Because it is the highest ionospheric region
D. All of these choices are correct

As we saw above, the F region is the highest region in the atmosphere so the correct answer is **C**. Answers A and B are technically incorrect so they are both wrong. Since Answers A and B are incorrect, Answer D cannot be correct.

G3C04 (D)
What does the term "critical angle" mean as used in radio wave propagation?
A. The long path azimuth of a distant station
B. The short path azimuth of a distant station
C. The lowest takeoff angle that will return a radio wave to the Earth under specific ionospheric conditions
D. The highest takeoff angle that will return a radio wave to the Earth under specific ionospheric conditions

The “critical angle” definition is given in answer **D** so that is the right choice. Answer C is just the opposite angle so it is wrong. Answers are just to distract you.

G3C05 (C)
Why is long distance communication on the 40, 60, 80 and 160 meter bands more difficult during the day?
A. The F layer absorbs these frequencies during daylight hours
B. The F layer is unstable during daylight hours
C. The D layer absorbs these frequencies during daylight hours
D. The E layer is unstable during daylight hours

The D region is the lowest region in the atmosphere and it tends to absorb long-wavelength radiation therefore the correct answer is **C**. Answers A, B and E are technically incorrect so they are just there to distract you.

G3C06 (B)
What is a characteristic of HF scatter signals?
A. They have high intelligibility
B. They have a wavering sound
C. They have very large swings in signal strength
D. All of these choices are correct

HF scatter is caused by the radiowaves being bounced back to the earth by small charged regions in the ionosphere. In this case, the ionosphere is acting like a bumpy mirror. Therefore a distorted signal is received. The best answer is then **B**. Answer A is just the opposite and wrong. Answer C is not correct because the signal strength may not have a large signal swing. Since Answers A and C are incorrect, Answer D is also incorrect..

G3C07 (D)
What makes HF scatter signals often sound distorted?
A. The ionospheric layer involved is unstable
B. Ground waves are absorbing much of the signal
C. The E-region is not present
D. Energy is scattered into the skip zone through several radio wave paths

Answers B and C are not correct technically so they are eliminated. Answer A may sound plausible but that is not as good a description as Answer D. This makes Answer **D** the best choice to answer the question.

G3C08 (A)
Why are HF scatter signals in the skip zone usually weak?
A. Only a small part of the signal energy is scattered into the skip zone
B. Signals are scattered from the troposphere which is not a good reflector
C. Propagation is through ground waves which absorb most of the signal energy
D. Propagations is through ducts in F region which absorb most of the energy

HF scatter is an E-region process in the ionosphere so answer D is wrong since it deals with the F region. Since it is an ionosphere process, there are no ground waves involved so we can eliminate answer C. Since the troposphere is not involved with radiowave scattering, Answer B is incorrect. The best choice is answer **A** and it correctly describes what happens to the radio energy.

```
G3C09 (B)
What type of radio wave propagation allows a signal to be detected at a
distance too far for ground wave propagation but too near for normal sky wave
propagation?
A. Ground wave
B. Scatter
C. Sporadic-E skip
D. Short-path skip
```

This is another way of saying E-region scatter process so the best answer is **B**. Do not be confused with C and D since they sound close but those are not the right terms – just use "scatter" as in answer B. Answer A is not correct because ground wave propagation is a relatively local means of communications and will not get you into the skip region that is beyond the ground wave region.

```
G3C10 (D)
Which of the following might be an indication that signals heard on the HF
bands are being received via scatter propagation?
A. The communication is during a sunspot maximum
B. The communication is during a sudden ionospheric disturbance
C. The signal is heard on a frequency below the maximum usable frequency
D. The signal is heard on a frequency above the maximum usable frequency
```

Answers A and B sound good because they are times when HF communications have difficulty. However, they are not specific enough to answer this question. If you are operating below the MUF, then things will work as expected so Answer C really will not help discriminate for scatter propagation. If you are able to operate above the MUF, then you may be benefitting from scatter so Answer **D** is the correct response.

```
G3C11 (A)
Which of the following is true about ionospheric absorption near the maximum
usable frequency (MUF)?
A. Absorption will be minimum
B. Absorption is greater for vertically polarized waves
C. Absorption approaches maximum
D. Absorption is greater for horizontally polarized waves
```

The answer here may seem to be counterintuitive: the absorption is at a minimum so answer **A** is the right choice to answer the question. Answer C might seem correct but it is the opposite of the correct choice. Polarization is not a factor in this instance so Answers B and D are incorrect.

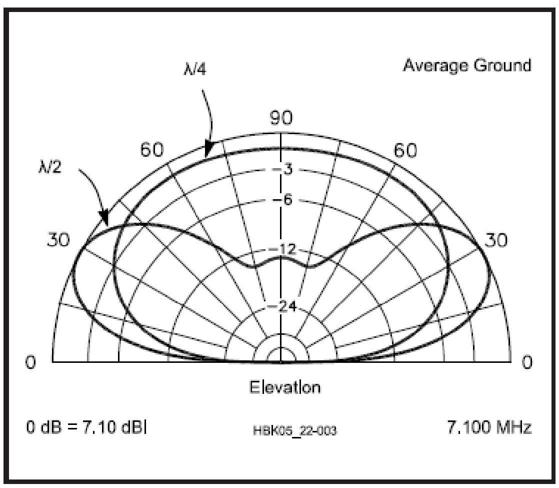
```
G3C12 (D)
Which ionospheric layer is the most absorbent of long skip signals during
daylight hours on frequencies below 10 MHz?
A. The F2 layer
B. The F1 layer
C. The E layer
D. The D layer
```

Here you need to remember that the D layer is the most absorbent during daylight hours so the correct choice is Answer **D.** The others are above the D layer in altitude so their effects are not as pronounced.

G3C13 (B)
What is Near Vertical Incidence Sky-wave (NVIS) propagation?
A. Propagation near the MUF
B. Short distance HF propagation using high elevation angles
C. Long path HF propagation at sunrise and sunset
D. Double hop propagation near the LUF

NVIS is a technique where a radio signal is transmitted almost straight up (high elevation angle). Most normal HF antennas send the radio signals close to the horizon so this is a major difference in antenna technology. The radio signals interact with the ionosphere and come back to the earth a relatively short distance, within 200 miles or so, from the transmitter. Here, short is relative to F-layer propagation. This makes Answer **B** the correct choice to answer this question. The other choices are technobabble distractions to see if you know what NVIS is.

G3C14 (B)
Which of the following antennas will be most effective for skip communications on 40 meters during the day?
A. A vertical antenna
B. A horizontal dipole placed between 1/8 and 1/4 wavelength above the ground
C. A left-hand circularly polarized antenna
D. A right-hand circularly polarized antenna



The polarization will not affect the skip so answers C and D can be spotted as distractions. During the day, the ionospheric D-layer will tend to absorb radio signals. A vertical antenna tends to radiate mostly towards the horizon so this radiation will be absorbed by the D-layer and not be available for skip propagation. This makes Answer A a bad choice for this question. Actually, this question is related to the NVIS question we just had. In this case, a horizontal dipole, as in Answer B, will have most of its radiation pointed towards the vertical direction and we can take advantage of NVIS scatter. This effect is shown in the graphic. This makes Answer **B** the best choice to answer this question.

Source: 2005 ARRL Handbook, Ver. 9. CD, Chap. 22.

G4 - Amateur Radio Practices

G4A01 (B)
Which of the following is one use for a DSP in an amateur station?
A. To provide adequate grounding
B. To remove noise from received signals
C. To increase antenna gain
D. To increase antenna bandwidth

Digital Signal Processing (DSP) works with audio signals. Therefore, it cannot help with grounding, antenna gain or antenna bandwidth. This makes Answers A, C, and D bad choices for this question. DSP can help to clean up (remove noise) from audio signals so Answer **B** is the correct choice.

G4A02 (B)
Which of the following instruments may be used to measure the output of a single-sideband transmitter when performing a two-tone test of amplitude linearity?
A. An audio distortion analyzer
B. An oscilloscope
C. A directional wattmeter
D. A high impedance audio voltmeter

An audio distortion analyzer is a good measurement to have but it is used on the final audio stage and not the SSB transmitter so Answer A is not a good choice. An oscilloscope is the test instrument used when making a two-tone test so Answer **B** is the right choice. A directional watt meter is incorrect because it is used with antenna power measurements. Answer D is technobabble.

G4A03 (D)
Which of the following is needed for a DSP IF filter?
A. An Analog to Digital Converter
B. Digital to Analog Converter
C. A Digital Processor Chip
D. All of the these answers are correct

Since each of the components in needed in constructing a DSP-based IF filter, the correct answer is Answer **D**.

G4A04 (A)
Which of the following is an advantage of a receiver IF filter created with a DSP as compared to an analog filter?
A. A wide range of filter bandwidths and shapes can be created
B. Fewer digital components are required
C. Mixing products are greatly reduced
D. The DSP filter is much more effective at VHF frequencies

Because the DSP characteristics can be changed by programming, a variety of component characteristics can be programmed into the circuitry. This makes Answer **A** the right choice. Answer B is incorrect – more digital components will be found. Answer C is incorrect because bad programming can really muck up the signals as well. Answer D is incorrect because many DSP systems will not be fast enough to work at VHF frequencies (at least for today!).

```
G4A05 (B)
How is DSP filtering accomplished?
A. By using direct signal phasing
B. By converting the signal from analog to digital and using digital
      processing
C. By up-converting the signal to VHF
D. By converting the signal from digital to analog and taking the difference
      of mixing products
```

Answers A and D are technobabble so they are not good choices. Answer C is a valid process but it is not filtering so this is not a good choice either. Answer **B** describes to correct process of analog-to-digital conversion and subsequent processing so it is the right answer.

```
G4A06 (B)
What reading on the plate current meter of a vacuum tube RF power amplifier
indicates correct adjustment of the plate tuning control?
A. A pronounced peak
B. A pronounced dip
C. No change will be observed
D. A slow, rhythmic oscillation
```

This is a description of how a “dip meter” works so the correct choice is Answer **B**. Answer A is just the opposite effect. Answers C and D are to distract you.

```
G4A07 (D)
What is the correct adjustment for the "Load" or "Coupling" control of a
vacuum tube RF power amplifier?
A. Minimum SWR on the antenna
B. Minimum plate current without exceeding maximum allowable grid current
C. Highest plate voltage while minimizing grid current
D. Maximum power output without exceeding maximum allowable plate current
```

Yes, vacuum tubes are still used in radio electronics, especially for high power signal generation. Plate currents and grid currents are two important parameters in vacuum tube circuit design. On an exam like this, you should be able to guess that maximizing power output from a circuit might be something that radio designers are interested in. Since most folks are not used to dealing with vacuum tubes, you will need to memorize that Answer **D** is the right choice.

```
G4A08 (C)
Which of the following techniques is used to neutralize an RF amplifier?
A. Feed-forward compensation
B. Feed-forward cancellation
C. Negative feedback
D. Positive feedback
```

Feedback circuitry is used in neutralization for RF amplifiers so we will choose the right answer from either C or D. Positive feedback can cause oscillations so answer D is eliminated. Negative feedback, or answer **C**, is the right choice.

```
G4A09 (B)
What does a neutralizing circuit do in an RF amplifier?
A. It controls differential gain
B. It cancels the effects of positive feedback
C. It eliminates AC hum from the power supply
D. It reduces incidental grid modulation
```

The correct answer here should be easy to spot based on the previous question. Answer **B** is the correct choice since the negative feedback cancels the positive feedback that can cause oscillations. The feedback does nothing for answers A and D so they can be eliminated. We can eliminate answer C since it deals with power supplies and not with amplifiers.

```
G4A10 (B)
What is the reason for neutralizing the final amplifier stage of a
transmitter?
A. To limit the modulation index
B. To eliminate self oscillations
C. To cut off the final amplifier during standby periods
D. To keep the carrier on frequency
```

Again, we should be able to spot answer **B** as the right one since it deals with oscillations. It will not affect the modulation or transmissions as in answers A and D. It will also not be used for the purpose of answer C.

```
G4A11 (A)
What type of transmitter performance does a two-tone test analyze?
A. Linearity
B. Carrier and undesired sideband suppression
C. Percentage of frequency modulation
D. Percentage of carrier phase shift
```

Based on the earlier question, you should be able to spot the term “linearity” in answer **A** as the right choice. It will not make any of the measurements given as the choices in answers B, C, or D so these are incorrect.

```
G4A12 (B)
What type of signals are used to conduct a two-tone test?
A. Two audio signals of the same frequency shifted 90-degrees
B. Two non-harmonically related audio signals
C. Two swept frequency tones
D. Two audio frequency range square wave signals of equal amplitude
```

The linearity test uses two non-harmonically related tones in the audio passband so answer **B** is the correct formulation of the test conditions. Answer A is incorrect because the tomes are at the same frequency. Answer C is incorrect because the tones need to be non-harmonically related so any arbitrary tones will not work. Answer D is incorrect because the square waves will produce many harmonically-related tones.

```
G4A13 (B)
Which of the following performs automatic notching of interfering carriers?
A. Band pass tuning
B. A DSP filter
C. Balanced mixing
D. A noise limiter
```

If properly designed, a DSP filter can be made to perform automatic notching of interfering carriers so Answer **B** is correct. Band pass tuning will tune across a specified band but not eliminate anything. Balanced mixing is good but will not eliminate carriers. A nosie limiter will limit signal amplitudes but not notch out carriers.

```
G4B01 (D)
What item of test equipment contains horizontal and vertical channel
amplifiers?
A. An ohmmeter
B. A signal generator
C. An ammeter
D. An oscilloscope
```

If you know your test equipment, then you will recognize the correct answer is **D**. Both ohmmeters and ammeters are single-channel devices so answers A and C are eliminated. A signal generator produces signals and does not display signals so answer B is eliminated.

```
G4B02 (D)
Which of the following is an advantage of an oscilloscope versus a digital
voltmeter?
A. An oscilloscope uses less power
B. Complex impedances can be easily measured
C. Input impedance is much lower
D. Complex waveforms can be measured
```

Answer A is incorrect – in fact the opposite is true. Many digital volt meters have means for measuring capacitive and inductive loads so Answer B is also incorrect. Both types of meters should have very high input impedances so Answer C is a bad choice. Complex waveforms can be measured on a ′scope so Answer **D** is the best choice.

```
G4B03 (D)
How would a signal tracer normally be used?
A. To identify the source of radio transmissions
B. To make exact drawings of signal waveforms
C. To show standing wave patterns on open-wire feed-lines
D. To identify an inoperative stage in a receiver
```

Signal tracers are used to identify inoperative components so answer **D** is the right choice. Answers A, B, and C might be measurements you desire to make but not with a signal tracer. Don't be confused with answer A which is an activity called "fox hunting." It may sound right but it is not what a signal tracer is for.

```
G4B04 (C)
How is a noise bridge normally used?
A. It is connected at an antenna's feed point and reads the antenna's noise
      figure
B. It is connected between a transmitter and an antenna and tuned for minimum
      SWR
C. It is connected between a receiver and an antenna of unknown impedance and
      is adjusted for minimum noise
D. It is connected between an antenna and ground and tuned for minimum SWR
```

Answer A sounds good but a noise bridge will not measure an antenna's noise figure. Minimum SWR is also a good operating characteristic but a noise bridge is not used on the transmission side so Answer B is related but not exactly the right reasoning. Answer **C** is the correct way a noise bridge is used so this is the correct choice. Answer D describes another incorrect way to use a noise bridge.

G4B05 (A)
Which of the following is the best instrument to use to check the keying waveform of a CW transmitter?
A. A monitoring oscilloscope
B. A field-strength meter
C. A sidetone monitor
D. A wavemeter

The monitoring oscilloscope of answer **A** is the best choice here for checking signal quality. Answer B is for measuring radiated RF signals and will not tell you the desired information. Answer D will tell if the signal is present but not tell you the quality of the signal so it is wrong as well although it may sound like a good answer. Answer C is just to distract you.

G4B06 (D)
What signal source is connected to the vertical input of a monitoring oscilloscope when checking the quality of a transmitted signal?
A. The local oscillator of the transmitter
B. The audio input of the transmitter
C. The transmitter balanced mixer output
D. The attenuated RF output of the transmitter

If you wish to check the transmitted signal, you should check the RF output as in answer **D**. Answers A, B, and C will not make the desired measurement because they are not made at the final stage of the transmission electronics chain. They are made at an earlier stage and "bad things" can still happen after each of these stages so checking the final output is the best choice.

G4B07 (C)
What is an advantage of a digital voltmeter as compared to an analog voltmeter?
A. Better for measuring computer circuits
B. Better for RF measurements
C. Significantly better precision for most uses
D. Faster response

A good digital voltmeter will give the user a result with higher precision than an analog voltmeter so Answer C is the best choice here. The other choices can be "ties" depending upon the quality of the respective meters.

G4B08 (A)
What instrument may be used to monitor relative RF output when making antenna and transmitter adjustments?
A. A field-strength meter
B. An antenna noise bridge
C. A multimeter
D. A Q meter

Here is another question on measuring RF fields so we use the field strength meter as in answer **A**. As we saw earlier, the noise bridge is for impedance matching. A multimeter measures voltages, currents and/or impedances. A Q meter is for checking the quality factor of inductors.

G4B09 (C)
How much must the power output of a transmitter be raised to change the "S" meter reading on a distant receiver from S8 to S9?
A. Approximately 2 times
B. Approximately 3 times
C. Approximately 4 times
D. Approximately 5 times

The S-meter scale is not exact from a measurement point of view. It is usually calibrated so that an increase of 1 S unit corresponds to a change of a factor of 4 in power. The correct answer is then choice **C**. Be careful because a power change of 2 times in answer A corresponds to 3 dB which is covered in other questions.

G4B10 (B)
Which of the following can be determined with a field strength meter?
A. The radiation resistance of an antenna
B. The radiation pattern of an antenna
C. The presence and amount of phase distortion of a transmitter
D. The presence and amount of amplitude distortion of a transmitter

The field strength measures the strength of the radiation coming off an antenna. By moving the meter around, you can trace out the antenna's pattern so Answer B is the right choice. It will not measure the antenna input so you cannot measure radiation resistance. It will not measure the distortions in the transmitter either.

G4B11 (A)
Which of the following might be a use for a field strength meter?
A. Close-in radio direction-finding
B. A modulation monitor for a frequency or phase modulation transmitter
C. An overmodulation indicator for a SSB transmitter
D. A keying indicator for a RTTY or packet transmitter

The field strength does not measure the content of the signal so the applications given in answers B, C, and D cannot me made with a field strength meter and these choices are incorrect. The radio direction finding work of answer A can be assisted by having a field strength meter so answer **A** is the right choice.

G4B12 (B)
What is one way a noise bridge might be used?
A. Determining an antenna's gain in dBi
B. Pre-tuning an antenna tuner
C. Pre-tuning a linear amplifier
D. Determining the line loss of the antenna system

The noise bridge cannot tell the user anything about the antenna's gain so answers A is eliminated. The noise bridge will assist in impedance matching so answer **B** is a correct choice. The pre-tuning of an amplifier is not associated with the impedance matching function son Answer C is not a good choice. While the noise bridge will assist in impedance matching, it will not determine line loss so answer D is also incorrect.

G4B13 (A)
What is one measurement that can be made with a dip meter?
A. The resonant frequency of a circuit
B. The tilt of the ionosphere
C. The gain of an antenna
D. The notch depth of a filter

The dip meter will assist you in finding the resonant frequency of an antenna so Answer **A** is the right choice. Answers B and C are silly distractions. Answer D cannot be found with other test equipment than a dip meter.

```
G4B14 (C)
Which of the following must be connected to an antenna analyzer when it is
being used for SWR measurements?
A. Receiver
B. Transmitter
C. Antenna and feedline
D. All of these answers are correct
```

This is one of those obvious ones once you think about it. To measure the antenna's SWR, you need to have the antenna and feedline connected so Answer C is the right choice. Answers A and B will not tell you about the antenna's SWR. Since A and B are incorrect, Answer D must be incorrect.

```
G4B15 (A)
Which of the following can be measured with a directional wattmeter?
A. Standing Wave Ratio
B. Antenna front-to-back ratio
C. RF interference
D. Radio wave propagation
```

A directional wattmeter gives you a measurement of transmitted and reflected signals which can be used to find the antenna's Standing Wave Ratio so Answer **A** is the right choice. The filed strength meter can be used to find the front-to-back ratio. Answers C and D cannot usually be determined with a single piece of test equipment.

```
G4B16 (D)
Why is high input impedance desirable for a voltmeter?
A. It improves the frequency response
B. It decreases battery consumption in the meter
C. It improves the resolution of the readings
D. It decreases the loading on circuits being measured
```

High impedance means that the meter looks like an open circuit. Open circuits do not draw current so it will not put a load on the circuits being measured. This makes Answer **D** the right choice. Answers A, B, and C have nothing to do with the input impedance of the meter so these are incorrect choices.

```
G4C01 (B)
Which of the following might be useful in reducing RF interference to
audio-frequency devices?
A. Bypass inductor
B. Bypass capacitor
C. Forward-biased diode
D. Reverse-biased diode
```

We need to understand a bit of electrical theory to answer this question. At the relatively high frequencies of radio signals, inductors tend to have higher impedance than do capacitors. If a capacitor is connected between the input and ground, then the radio signal causing the interference will see a low-impedance path to the ground (shunted to ground) and be removed. This is the desired action and the bypass capacitor of Answer **B** is the right choice. The inductor placed as a bypass circuit element will have a high impedance and not work. Diodes are not effective here because the RF signal has both positive and negative amplitudes and the ones in Answers C and D will still conduct in one direction.

G4C02 (B)
Which of the following should be installed if a properly operating amateur station is interfering with a nearby telephone?
A. An RFI filter on the transmitter
B. An RFI filter at the affected telephone
C. A high pass filter on the transmitter
D. A high pass filter at the affected telephone

A filter on the transmitter is not required if the transmitting station is in good working order. The problem is on the telephone end so we can eliminate Answers A and C. We do wish to have a filter and the correct technical term is an Radio Frequency Interference (RFI) filter so Answer **B** is the best choice.

G4C03 (C)
What sound is heard from a public-address system if there is interference from a nearby single-sideband phone transmitter?
A. A steady hum whenever the transmitter is on the air
B. On-and-off humming or clicking
C. Distorted speech
D. Clearly audible speech

Answers C and D look reasonable at first glance since they contain speech signals as part of the answer. However, the audio rectification process on a PA system is not a well designed receiver so the speech output will be distorted and answer **C** is the best choice. Answer D is what happens in a proper receiver so it is out of consideration. Answer B is what is expected from CW transmissions so it is not a good choice. Answer A would be more typical of an unmodulated carrier so it is also eliminated.

G4C04 (A)
What is the effect on a public-address system if there is interference from nearby CW transmitter?
A. On-and-off humming or clicking
B. A CW signal at a nearly pure audio frequency
C. A chirpy CW signal
D. Severely distorted audio

Now we move from phone transmissions to CW. Answer D was the right answer for phone emissions so it is the wrong answer here. Answer B would be the result of a good receiver and not interference through a PA system so Answer B is also eliminated. The humming and clicking of Answer **A** is the right choice. Answer C is not caused by PA system rectification.

G4C05 (D)
What might be the problem if you receive an RF burn when touching your equipment while transmitting on a HF band, assuming the equipment is connected to a ground rod?
A. Flat braid rather than round wire has been used for the ground wire
B. Insulated wire has been used for the ground wire
C. The ground rod is resonant
D. The ground wire is resonant

The usual cause for this type of problem is that the ground wire between the transmitted and the ground rod physically in the ground is resonant (acting like a tuned antenna) at the transmission frequency. This makes Answer **D** the right choice. The ground rod is important in the system but it is not the cause so Answer C is not correct. Answers A and B are silly distractions.

G4C06 (D)
Which of the following is an important reason to have a good station ground?
A. To reduce the likelihood of RF burns
B. To reduce the likelihood of electrical shock
C. To reduce interference
D. All of these answers are correct

Since each item mentioned in Answers A, B, and C is important, Answer **D** is the right choice.

G4C07 (A)
What is one good way to avoid stray RF energy in an amateur station?
A. Keep the station's ground wire as short as possible
B. Install an RF filter in series with the ground wire
C. Use a ground loop for best conductivity
D. Install a few ferrite beads on the ground wire where it connects to your station

This is another question about grounding and answer **A** is the best choice given. Answer B is not true. Answer C is technobabble and ground loops are to be avoided! The ferrite beads of Answer D are frequently used for common mode noise suppression in cables but they will not prevent stray RF.

G4C08 (A)
Which of the following is a reason to place ferrite beads around audio cables to reduce common mode RF interference?
A. They act as a series inductor
B. They act as a shunt capacitor
C. They lower the impedance of the cable
D. They increase the admittance of the cable

Answers C and D are technobabble here so they are not good choices. We saw Answer B when discussing bypass capacitors but ferrite beads are not capacitors so Answer B is also incorrect. The beads do act as series inductors which makes Answer **A** correct.

G4C09 (C)
Which of the following statements about station grounding is true?
A. The chassis of each piece of station equipment should be tied together with high-impedance conductors
B. If the chassis of all station equipment is connected with a good conductor, there is no need to tie them to an earth ground
C. RF hot spots can occur in a station located above the ground floor if the equipment is grounded by a long ground wire
D. A ground loop is an effective way to ground station equipment

High-impedance conductors make for bad grounding wires so answer A is eliminated. Answer B is wrong because the system ground is not complete. Answer D is wrong because ground loops are to be avoided for proper operation. The only true statement is the one in Answer **C** so it is the right choice here.

```
G4C10 (C)
Which of the following is covered in the National Electrical Code?
A. Acceptable bandwidth limits
B. Acceptable modulation limits
C. Electrical safety inside the ham shack
D. RF exposure limits of the human body
```

Unless you have a copy of the NEC available, you will need to remember that the NEC only covers electrical safety of the choices given here. This makes Answer **C** the correct choice.

```
G4C11 (A)
Which of the following can cause unintended rectification of RF signal energy
and can result in interference to your station as well as nearby radio and TV
receivers?
A. Induced currents in conductors that are in poor electrical contact
B. Induced voltages in conductors that are in good electrical contact
C. Capacitive coupling of the RF signal to ground
D. Excessive standing wave ratio (SWR) of the transmission line system
```

The unintended rectification is caused by induced currents so Answer **A** is the correct choice. Be careful with Answer B because it lists voltage instead of the correct answer having current. Answer C is the shunt or bypass capacitor which helps to remove these types of currents. The high SWR of Answer D is not good but it is not the cause of unwanted rectification.

```
G4C12 (C)
What is one cause of broadband radio frequency interference at an amateur
radio station?
A. Not using a balun or line isolator to feed balanced antennas
B. Lack of rectification of the transmitter's signal in power conductors
C. Arcing at a poor electrical connection
D. The use of horizontal, rather than vertical antennas
```

Answer A might give an inefficient transmission but it will not cause RFI so this is not a good choice. We wish to avoid rectification in the power system so answer B is also a bad choice. Answer D is a silly distraction. The arcing of Answer **C** is the right choice.

```
G4C13 (D)
How can a ground loop be avoided?
A. Series connect all ground conductors
B. Connect the AC neutral conductor to the ground wire
C. Avoid using lock washers and star washers in making ground connections
D. Connect all ground conductors to a single point
```

The best remedy is to have a single ground reference point as in Answer **D**. Answer A may sound like the same thing but it is not electrically. Answer C is a silly distraction. Answer B will probably cause a bad result in you electrical wiring.

G4D01 (D)
What is the reason for using a properly adjusted speech processor with a single sideband phone transmitter?
A. It reduces average transmitter power requirements
B. It reduces unwanted noise pickup from the microphone
C. It improves voice-frequency fidelity
D. It improves signal intelligibility at the receiver

Answer **D** is the right choice because it tells what a speech processor does – it increases the amplitude of the audio input to make the quieter speech segments louder and easier to understand. Answer C sounds close but that is not the correct response because the speech processor deals with the audio signal input amplitude and not its frequency content. Answers A and B also sound reasonable but are not the best choice for this question. In fact, answer A is just the opposite of what happens with a speech processor.

G4D02 (B)
Which of the following describes how a speech processor affects a transmitted single sideband signal?
A. It increases the peak power
B. It increases the average power
C. It reduces harmonic distortion
D. It reduces intermodulation distortion

The correct technical description of how a speech processor works was given in the previous answer. This results in greater average power so Answer **B** is the right choice. It does not enhance large-amplitude signals so it does not increase peak power as in Answer A. Answers C and D would be nice to have but they are not things a speech processor can do so they are eliminatd.

G4D03 (D)
Which of the following can be the result of an incorrectly adjusted speech processor?
A. Distorted speech
B. Splatter
C. Excessive background pickup
D. All of these answers are correct

Since an incorrectly adjusted speech processor can cause each of the effects given in Answers A, B, and C, the correct choice is Answer **D**.

G4D04 (C)
What does an S-meter measure?
A. Conductance
B. Impedance
C. Received signal strength
D. Transmitter power output

You will find an S-meter on your receiver and it is used to measure received signal strength so Answer **C** is the right choice. Answers A and B are typically measured with various types of multimeters so they are incorrect here. Another meter on your transceiver will typically measure transmitted power.

```
G4D05 (D)
How does an S-meter reading of 20 db over S-9 compare to an S-9 signal,
assuming a properly calibrated S meter?
A. It is 10 times weaker
B. It is 20 times weaker
C. It is 20 times stronger
D. It is 100 times stronger
```

The dB scale is logarithmic and a 20 dB increase is a factor of 100 in power so Answer **D** is the correct choice. The other options are to see if you know what a dB means.

```
G4D06 (A)
Where is an S-meter generally found?
A. In a receiver
B. In a SWR bridge
C. In a transmitter
D. In a conductance bridge
```

As we saw above, the S-meter is found on a receiver so Answer **A** is correct. The other choices are to see if you know your equipment.

```
G4D07 (A)
Which of the following describes a Type-N connector?
A. A moisture resistant RF connector useful to 10 GHz
B. A small bayonet connector used for data circuits
C. A threaded connector used for hydraulic systems
D. An audio connector used in surround sound installations
```

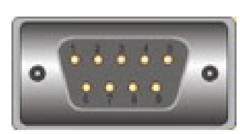
A Type-N connector is described in Answer **A** so this is the right choice. This is a RF connector and not audio so Answer D is eliminated. Hydraulics are not used in RF connectors so Answer C is eliminated. Answer B is close to the description of a BNC connector so it is not a good choice here.

```
G4D08 (D)
Which of the following connectors would be a good choice for a serial data
port?
A. PL-259
B. Type N
C. Type SMA
D. DB-9
```

PL-259 connector

N-Type connector

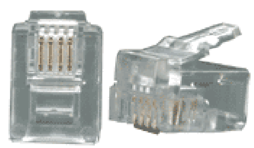
SMA connector



DB-9 connector

If you have set up antenna, radio and computer equipment, you will recognize that each of the connectors listed in Answers A through D are used somewhere in those electronics. The only one that is not designed for RF but is designed for serial data communications is the DB-9 computer cable connector listed in answer **D** so that is the right choice for this question. The other connectors are for various RF applications.

```
G4D09 (C)
Which of these connector types is commonly used for RF service at frequencies
up to 150 MHz?
A. Octal
B. RJ-11
C. UHF
D. DB-25
```



RJ-11 connector

UHF Connector

DB-25 connector

The DB-25 in Answer D is a computer serial data cable so it is not good for RF. The RJ-11 is a telephone connector so it is also not a good choice for an RF connection. The octal connector mentioned in Answer A is not a specific connector so it is also a bad choice. The UHF connector of Answer **C** is the right choice. Notice, this UHF connector is really the same thing as a PL-259! Also, even though it is called a UHF connector, it is not typically used in the UHF band. This is just an old (WWII vintage) designation.

```
G4D10 (C)
Which of these connector types is commonly used for audio signals in amateur
radio stations?
A. PL-259
B. BNC
C. RCA Phono
D. Type N
```

N-Type connector

RCA Phono

PL-259 Connector

BNC connector

The RCA phono connector listed in Answer **C** is the only audio connector in the list so this is the correct choice. The other three connectors are for RF so they are not good choices for audio connections.

G4D11 (B)
What is the main reason to use keyed connectors over non-keyed types?
A. Prevention of use by unauthorized persons
B. Reduced chance of damage due to incorrect mating
C. Higher current carrying capacity
D. All of these choices are correct

Idiot-proofing is so hard because idiots are so inventive. Keying a connector helps with idiot-proofing and keeping damage to a minimum. This makes answer **B** the right choice. Answers A and C are not affected by keying so they are eliminated. With those two gone, Answer D cannot be correct.

G4E01 (D)
Which of the following emission types are permissible while operating HF mobile?
A. CW
B. SSB
C. FM
D. All of these choices are correct

The radio regulations permit all three modes mentioned in Answers A, B, and C so the correct choice is Answer **D**.

G4E02 (C)
What is alternator whine?
A. A DC emission from the alternator
B. A constant pitched tone or buzz in transmitted or received audio that occurs whenever the ignition key is in the on position
C. A tone or buzz in transmitted or received audio that varies with engine speed
D. A mechanical sound from the alternator indicating current overload

If you have heard this, you would remember it. Alternator whine is a tone or buzz heard in the audio that varies with engine speed. This makes Answer **C** the correct choice. A mechanical sound indicates a mechanical problem so Answer D is incorrect. Alternator whine is not constant pitched so Answer B is incorrect. DC emissions are not whines so Answer A is incorrect.

G4E03 (A)
Which of the following power connections would be the best for a 100-watt HF mobile installation?
A. A direct, fused connection to the battery using heavy gauge wire
B. A direct, fused connection to the alternator or generator using heavy gauge wire
C. A direct, fused connection to the battery using resistor wire
D. A direct, fused connection to the alternator or generator using resistor wire

Answers C and D might not be rated for the necessary current draw so they are not the best choices. Answers B and D are not good because the rig requires a DC input and the alternator or generator produces an AC output. Answer **A** is the correct choice.

G4E04 (B)
Why is it best NOT to draw the DC power for a 100-watt HF transceiver from an automobile's cigarette lighter socket?
A. The socket is not wired with an RF-shielded power cable
B. The socket's wiring may be inadequate for the current being drawn by the transceiver
C. The DC polarity of the socket is reversed from the polarity of modern HF transceivers
D. The power from the socket is never adequately filtered for HF transceiver operation

The 100-watt rig will draw a relatively large current. Of the statements given, the best reason is answer **B**. Generally, the wiring to the socket is not really very good for RF work. However, since Answer B points to a large safety hazard, it is the best choice to answer this question.

G4E05 (C)
Which of the following most limits the effectiveness of an HF mobile transceiver operating in the 75 meter band?
A. "Picket Fencing" signal variation
B. The wire gauge of the DC power line to the transceiver
C. The HF mobile antenna system
D. FCC rules limiting mobile output power on the 75 meter band

Answers A describes audio cut-out near the capture threshold of a receiver and is not a general characteristic across the entire band so this is not a good choice. Answer B is not relevant to effective transmission as long as it is safe for the required current. Answer D is not true for General-Class operators since they do not have the 200-W limitation. The best choice is answer **C**. This makes sense since the antenna is a large fraction of the wavelength or somewhat longer than the vehicle.

G4E06 (A)
Which of the following is true of an emergency generator installation?
A. The generator should be located in a well ventilated area
B. The generator should be insulated from ground
C. Fuel should be stored near the generator for rapid refueling in case of an emergency
D. All of these choices are correct

Answers B and C are incorrect and this makes Answer D incorrect as well. Proper ventilation is important so Answer **A** is the best choice here.

G4E07 (C)
When might a lead-acid storage battery give off explosive hydrogen gas?
A. When stored for long periods of time
B. When being discharged
C. When being charged
D. When not placed on a level surface

Answer B is the opposite of the true condition so it is eliminated. Answer A and answer D are both wrong chemically. The correct answer is **C**.

G4E08 (A)
What is the name of the process by which sunlight is changed directly into electricity?
A. Photovoltaic conversion
B. Photon emission
C. Photosynthesis
D. Photon decomposition

Answer D is a silly distraction. Answer C is true for plants and is also a bit silly in this context. Answer B is techno-babble and not a good choice for photcells. Answer **A** is the right choice for this question.

G4E09 (B)
What is the approximate open-circuit voltage from a modern, well illuminated photovoltaic cell?
A. 0.02 VDC
B. 0.5 VDC
C. 0.2 VDC
D. 1.38 VDC

You need to remember that the correct choice is answer **B**. The others are not typical for modern photocells.

G4E10 (A)
Which of these materials is used as the active element of a solar cell?
A. Doped Silicon
B. Nickel Hydride
C. Doped Platinum
D. Aluminum nitride

Solar cells are made from the same materials as found in many transistor semiconductors – doped silicon. This makes Answer A the correct choice. Answer B is part of battery technology. Answer C is a distraction. Aluminum nitride found in Answer D is not currently used in photocells but it is use in other semiconductor applications such as LEDs.

G4E11 (C)
Which of the following is a disadvantage to using wind power as the primary source of power for an emergency station?
A. The conversion efficiency from mechanical energy to electrical energy is less that 2 percent
B. The voltage and current ratings of such systems are not compatible with amateur equipment
C. A large energy storage system is needed to supply power when the wind is not blowing
D. All of these choices are correct

Answer A may be true in a given configuration but not as big of a disadvantage as choice C. Answer B is also not necessarily true. Since answers A and B are eliminated, answer D is also eliminated. Answer **C** is the only one that is true all of the time and, therefore, is the best choice for this question.

```
G4E12 (A)
Which of the following is a primary reason for not placing a gasoline-fueled
generator inside an occupied area?
A. Danger of carbon monoxide poisoning
B. Danger of engine over torque
C. Lack of oxygen for adequate combustion
D. Lack of nitrogen for adequate combustion
```

A gasoline engine will produce carbon monoxide so Answer **A** is the correct choice. Answer B is really not relevant. Answer C will at least not kill you. Answer D is incorrect because engines do not use nitrogen.

```
G4E13 (A)
Why would it be unwise to power your station by back feeding the output of a
gasoline generator into your house wiring by connecting the generator through
an AC wall outlet?
A. It might present a hazard for electric company workers
B. It is prone to RF interference
C. It may disconnect your RF ground
D. None of the above; this is an excellent expedient
```

Answer **A** is the correct choice among those given. Since A is correct, Answer D must be incorrect. Answers B and C are not correct either.

Subelement G5 - Electrical Principles

```
G5A01 (C)
What is impedance?
A. The electric charge stored by a capacitor
B. The inverse of resistance
C. The opposition to the flow of current in an AC circuit
D. The force of repulsion between two similar electric fields
```

You need to remember that impedance is any opposition to the flow of AC current. The best choice is answer **C**. The other choices are incorrect definitions of impedance.

```
G5A02 (B)
What is reactance?
A. Opposition to the flow of direct current caused by resistance
B. Opposition to the flow of alternating current caused by capacitance or
      inductance
C. A property of ideal resistors in AC circuits
D. A large spark produced at switch contacts when an inductor is deenergized
```

The reactance is the magnitude of the impedance for inductors and capacitors so it has the same effect on AC currents. Therefore, the reactance is also any opposition to the flow of AC current. The best choice is answer **B**. Be careful with answer A because reactance does not apply to resistors. The other choices are incorrect.

```
G5A03 (D)
Which of the following causes opposition to the flow of alternating current in
an inductor?
A. Conductance
B. Reluctance
C. Admittance
D. Reactance
```

From the previous two questions, you should be able to spot answer **D** as the right choice. Reluctance is the opposition to magnetic flux and is similar to impedance but for magnetic currents. Conductance and admittance are real electrical quantities but are not the best choice here.

```
G5A04 (C)
Which of the following causes opposition to the flow of alternating current in
a capacitor?
A. Conductance
B. Reluctance
C. Reactance
D. Admittance
```

Like the previous questions, you should be able to spot answer **C** as the right choice. Again, reluctance is the opposition to magnetic flux. As before, conductance and admittance are real electrical quantities but are not the best choice here.

G5A05 (D)
How does a coil react to AC?
A. As the frequency of the applied AC increases, the reactance decreases
B. As the amplitude of the applied AC increases, the reactance increases
C. As the amplitude of the applied AC increases, the reactance decreases
D. As the frequency of the applied AC increases, the reactance increases

The properties of inductors and capacitors are determined by the frequency of the signal and not the amplitude so we can eliminate answers B and C from consideration. Inductors and capacitors respond to the signal frequency in opposite ways. An inductor has a higher resistance to current flow as the frequency of the signal increases ($X_L = 2\pi fL$). This is why a coil is sometimes called a choke and the correct answer is **D**. Answer A is for a capacitor so be careful.

G5A06 (A)
How does a capacitor react to AC?
A. As the frequency of the applied AC increases, the reactance decreases
B. As the frequency of the applied AC increases, the reactance increases
C. As the amplitude of the applied AC increases, the reactance increases
D. As the amplitude of the applied AC increases, the reactance decreases

Now we examine the capacitor. From the previous question, we know that we can eliminate answers C and D from consideration since they deal with amplitude. A capacitor has a higher resistance to current flow as the frequency of the signal decreases ($X_C = 1/2\pi fC$). This is why a capacitor is sometimes used to block DC and the correct answer is **A**. Answer B is for an inductor so be careful not to choose it here.

G5A07 (D)
What happens when the impedance of an electrical load is equal to the internal impedance of the power source?
A. The source delivers minimum power to the load
B. The electrical load is shorted
C. No current can flow through the circuit
D. The source can deliver maximum power to the load

Electrically, this condition produces a maximum power transfer between the source and the load – a good thing. You should be able to spot answer **D** as the right choice for this question. Answer A is the opposite to the right answer so we can eliminate it. Answers B and C are electrically wrong so they are out too.

G5A08 (A)
Why is impedance matching important?
A. So the source can deliver maximum power to the load
B. So the load will draw minimum power from the source
C. To ensure that there is less resistance than reactance in the circuit
D. To ensure that the resistance and reactance in the circuit are equal

This is a statement of the maximum power principle in circuit analysis. This makes answer **A** as the right choice for this question. Be careful with choice B. This question is not asking you if the component draws the least amount electricity from the power supply or the wall plug. It is asking about the efficiency of moving the available signal power from one component to another. As written here, answer B is the opposite of the desired effect so we can eliminate it. Answers C and D are electrically wrong so we throw them out too.

G5A09 (B)
What unit is used to measure reactance?
A. Farad
B. Ohm
C. Ampere
D. Siemens

The reactance of a device is measured in Ohms so the correct choice is answer **B**. Amperes is for current so answer C is out. The Farad in Answer A is to measure capacitance while “Siemens” in answer D is used to measure conductance, the reciprocal of resistance.

G5A10 (B)
What unit is used to measure impedance?
A. Volt
B. Ohm
C. Ampere
D. Watt

Resistance and reactance both use Ohms to measure their impedance so the correct answer is **B**. Volts are the units for electrical potential, amperes are the units for electrical current and Watts are the units for electrical power and are not the right choices for this question.

G5A11 (A)
Why should core saturation of a conventional impedance matching transformer be avoided?
A. Harmonics and distortion could result
B. Magnetic flux would increase with frequency
C. RF susceptance would increase
D. Temporary changes of the core permeability could result

Core saturation can produce harmonics so Answer **A** is the correct choice. Answers B, C, and D do not happen electrically in this case.

G5A12 (B)
What is one reason to use an impedance matching transformer?
A. To reduce power dissipation in the transmitter
B. To maximize the transfer of power
C. To minimize SWR at the antenna
D. To minimize SWR in the transmission line

The general reason is to maximize power transfer so Answer **B** is the best choice for this question. Answers C and D may result if this is the configuration in question. They are not the best choices because there are possibilities for using matching transformers such as with speakers. Answer A is not what a matching transformer does.

G5A13 (D)
Which of the following devices can be used for impedance matching at radio frequencies?
A. A transformer
B. A Pi-network
C. A length of transmission line
D. All of these choices are correct

Circuits using each of the techniques given in Answers A, B, and C can be used to make a matching network so the best choice is Answer **D**.

G5A14 (A)
Which of the following describes one method of impedance matching between two AC circuits?
A. Insert an LC network between the two circuits
B. Reduce the power output of the first circuit
C. Increase the power output of the first circuit
D. Insert a circulator between the two circuits

An impedance matching network can be constructed from inductors and capacitors so Answer **A** is the right method. Answers B and C will reduce signal amplitude but not cure the impedance mismatch. Answer D is used to control the flow of RF signals so it will not match impedances.

G5B01 (B)
A two-times increase or decrease in power results in a change of how many dB?
A. 2 dB
B. 3 dB
C. 6 dB
D. 12 dB

You need to remember that a 2-times change in power is a 3 dB (10 log(2) = 3 dB) change so the correct answer is choice **B**. The others do not compute properly. Be careful with answer C since 6 dB is a factor of 4 which corresponds to one S-unit.

G5B02 (C)
How does the total current relate to the individual currents in each branch of a parallel circuit?
A. It equals the average of each branch current
B. It decreases as more parallel branches are added to the circuit
C. It equals the sum of the currents through each branch
D. It is the sum of the reciprocal of each individual voltage drop

When a circuit has several resistors in parallel, the current splits and is divided among the branch devices such that the sum of the branch currents equals the total current. Therefore, answer **C** is the correct choice. Answer A is wrong because it deals with the average current and not the total current at every instant. Answers B and D are electrically wrong.

G5B03 (B)
How many watts of electrical power are used if 400 VDC is supplied to an 800-ohm load?
A. 0.5 watts
B. 200 watts
C. 400 watts
D. 3200 watts

Power is voltage times the current (voltage x current). By Ohm's law we can write equivalent expressions: power is the square of the voltage divided by the resistance ($voltage^2 \div resistance$) or power is the square of the current times the resistance ($current^2 \times resistance$). Here, power is 400 x 400 or 160000 divided by 800 giving 200 Watts as in answer **B**. Answers A, C, and D represent math mistakes. Answer A is voltage ÷ resistance and not $voltage^2 \div resistance$ as required. Answer D is the product voltage x resistance and not voltage x current or $current^2 \times resistance$ as is required.

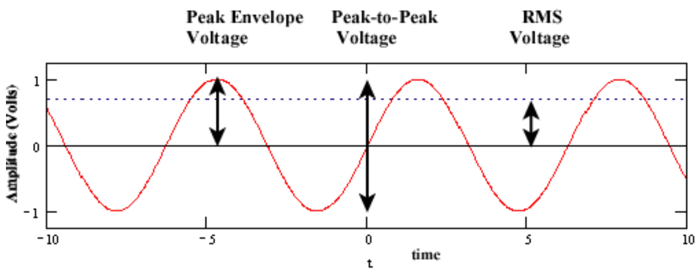
G5B04 (A)
How many watts of electrical power are used by a 12-VDC light bulb that draws 0.2 amperes?
A. 2.4 watts
B. 24 watts
C. 6 watts
D. 60 watts

If we multiply 12 Volts by 0.2 amperes, we get a result of 2.4 Watts or answer **A**. Be careful with answer B because it has the right digits but the wrong decimal place. Answers C and D are more math mistakes. Answer D is voltage ÷ current and not voltage x current as needed for the right answer.

G5B05 (A)
How many watts are being dissipated when a current of 7.0 milliamperes flows through 1.25 kilohms?
A. Approximately 61 milliwatts
B. Approximately 39 milliwatts
C. Approximately 11 milliwatts
D. Approximately 9 milliwatts

Power is the square of the current times the resistance ($current^2 \times resistance$). Neglecting the millis and the kilos for a moment, 7 squared is 49 and the resistance is 1.25 which will give us something in the neighborhood of 60. Answers B, C, and D are all smaller than the 49 we got from squaring the current so we can eliminate them. If we use a calculator, we can compute that 7 milliamps squared times 1.25 kilohms will give 61 milliwatts of power confirming our quick estimation that answer **A** is the right choice.

G5B06 (B)
What is the output PEP from a transmitter if an oscilloscope measures 200 volts peak-to-peak across a 50-ohm dummy load connected to the transmitter output?
A. 1.4 watts
B. 100 watts
C. 353.5 watts
D. 400 watts



The Peak Envelope Power (PEP) is the largest average power over a carrier cycle. For a sinusoidal signal, the PEP is defined in terms of the RMS, voltage. The RMS voltage is the Peak Envelope Voltage (PEV) divided by $\sqrt{2}$ ($\sqrt{2} = 1.414$) or multiplied by 0.707 ($1/\sqrt{2} = 0.707$). The relationship between voltage and power is that the power is the square of the voltage divided by the load resistance, R_L. Putting all of these concepts together gives $PEP = PEV^2/(2*R_L)$. The peak envelope voltage is ½ the peak-to-peak voltage or 100 Volts. We square this quantity and then divide the result by 2 times the 50-ohm load resistance so the PEP is (100 x 100) ÷ (2 x 50) or 100 Watts. The correct choice is answer **B**. The other answers represent various math errors.

G5B07 (C)
Which measurement of an AC signal is equivalent to a DC voltage of the same value?
A. The peak-to-peak value
B. The peak value
C. The RMS value
D. The reciprocal of the RMS value

The RMS value provides the DC equivalent for an AC signal so Answer **C** is the correct choice.

G5B08 (D)
What is the peak-to-peak voltage of a sine wave that has an RMS voltage of 120 volts?
A. 84.8 volts
B. 169.7 volts
C. 240.0 volts
D. 339.4 volts

The peak envelope voltage is $\sqrt{2}$ times the RMS voltage. Using the numbers given, V_{peak} = 1.41 x 120 V= 169.7 V. The peav-to-peak voltage is twice this value or V_{pp} = 2 x 169.71 V = 339.4 V. This makes Answer **D** the correct response. The others represent math errors. Be careful with Answer B because it is the peak value and not peak-to-peak.

G5B09 (B)
What is the RMS voltage of sine wave with a value of 17 volts peak?
A. 8.5 volts
B. 12 volts
C. 24 volts
D. 34 volts

We get to use the formulas again for this question. $V_{RMS} = V_{peak}/\sqrt{2}$ = 17 V/ $\sqrt{2}$ = 12 V. This makes Answer **B** the correct computation. Be careful with Answer A because it uses 2 and not $\sqrt{2}$. Answer C is V_{peak} x 2 while Answer D is a math error.

G5B11 (B)
What is the ratio of peak envelope power to average power for an unmodulated carrier?
A. .707
B. 1.00
C. 1.414
D. 2.00

If we have an unmodulated carrier, then the waveform is a pure sinusoid. In this case, the peak envelope power is the same as the RMS power so to ratio is 1.00 as in answer **B**. The other choices reflect misunderstandings of the definitions.

G5B12 (B)
What would be the voltage across a 50-ohm dummy load dissipating 1200 watts?
A. 173 volts
B. 245 volts
C. 346 volts
D. 692 volts

Here, we need to invert the equation used above. The peak voltage, PEV, is computed using PEV = $(2*RL*PEP)^{1/2}$ =

(2*50*1200) = 346 V. This makes answer **C** the right choice. Answer B is incorrect because it forgets the factor of 2. Answers A and D represent other math mistakes.

G5B13 (C)
What percentage of power loss would result from a transmission line loss of 1 dB?
A. 10.9 %
B. 12.2 %
C. 20.5 %
D. 25.9 %

A loss of 1 dB corresponds to L = $10^{(-1*0.1)}$ = 0.794. Since dB is a power ratio, the signal has 79.4% of its original power. This means that it has lost 20.6% of the original power. Answer **C** is the closest so this is the best choice for this computation.

G5B14 (B)
What is the output PEP from a transmitter if an oscilloscope measures 500 volts peak-to-peak across a 50-ohm resistor connected to the transmitter output?
A. 8.75 watts
B. 625 watts
C. 2500 watts
D. 5000 watts

Here we use the same equation as in the earlier question. The peak envelope voltage is ½ the peak-to-peak voltage or 250 Volts. We square this quantity and then divide the result by 2 times the 50-ohm load resistance or the PEP is (250 x 250) ÷ (2 x 50) or 625 Watts. The correct choice is answer **B**. The other choices have math errors.

G5B15 (B)
What is the output PEP of an unmodulated carrier if an average reading wattmeter connected to the transmitter output indicates 1060 watts?
A. 530 watts
B. 1060 watts
C. 1500 watts
D. 2120 watts

This is an interesting case: the average power of an unmodulated carrier as measured by the averaging wattmeter is the PEP power. Therefore, the right choice is answer **B**. The other answers are just to see if you understand this basic principle.

G5C01 (C)
What causes a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding?
A. Capacitive coupling
B. Displacement current coupling
C. Mutual inductance
D. Mutual capacitance

Since transformers deal with inductance, you should be able to eliminate answers A and D since they involve capacitance. Mutual inductance, as given in answer **C**, is the correct term for this effect. Answer B is technobabble to distract you.

G5C02 (B)
Where is the source of energy normally connected in a transformer?
A. To the secondary winding
B. To the primary winding
C. To the core
D. To the plates

A transformer normally has the energy source connected to the primary winding so Answer **B** is the right choice. The secondary, Answer A, is where the load is attached. Normally, nothing is connected to the core, especially if it is air. Transformers do not have plates.

G5C03 (A)
What is current in the primary winding of a transformer called if no load is attached to the secondary?
A. Magnetizing current
B. Direct current
C. Excitation current
D. Stabilizing current

Electrical engineers call the primary current when no load is attached the magnetizing current so Answer **A** is the right choice. The others are to distract you.

G5C04 (C)
What is the total resistance of three 100-ohm resistors in parallel?
A. .30 ohms
B. .33 ohms
C. 33.3 ohms
D. 300 ohms

When same-size resistors are attached in parallel, the total resistance is *R/N* where *R* is the individual resistor value and *N* is the number of resistors combined. Answer C computes to the right value of 33.3 Ω. The others represent various math errors.

G5C05 (C)
What is the value of each resistor if three equal value resistors in parallel produce 50 ohms of resistance, and the same three resistors in series produce 450 ohms?
A. 1500 ohms
B. 90 ohms
C. 150 ohms
D. 175 ohms

If three equal resistors are in parallel, then the resulting combined resistance is ⅓ of the original value. Likewise, if three equal resistors are in series, then the result is 3 times the original value. Either way, the 150 Ω in answer **C** is the correct choice. The other choices are distraction answers to see if you know how multiple resistors in series and parallel combine.

G5C06 (C)
What is the voltage across a 500-turn secondary winding in a transformer if the 2250-turn primary is connected to 120 VAC?
A. 2370 volts
B. 540 volts
C. 26.7 volts
D. 5.9 volts

Here we are doing a step-down voltage transformation (fewer turns on the secondary than on the primary). Since we are stepping the voltage down, the output voltage needs to be smaller than the input voltage so we can eliminate answers A and B. The step-down ratio is `N1/N2 = 2250/500` or 4.5. The voltage reduction will be 120 V ÷ 4.5 or 26.7 Volts. Answer **C** corresponds to this voltage so it is the right answer. We can do this computation without a calculator if we see that the step-down ratio is around a factor of 4 so the voltage reduction will be about the same. One-quarter of 120 will be around 30 and answer C is the only close answer so that is our best choice. Answer D is too large of a step down.

```
G5C07 (A)
What is the turns ratio of a transformer used to match an audio amplifier
having a 600-ohm output impedance to a speaker having a 4-ohm impedance?
A. 12.2 to 1
B. 24.4 to 1
C. 150 to 1
D. 300 to 1
```

When using the turns ratio to compute the resistance needed, we use the square root of the ratio. The ratio of 600 to 4 is 150 which is answer C. However, this is the wrong answer because we need to take the square root of this or 12.2 which is found in answer **A**. The other two answers are math mistakes.

```
G5C08 (D)
What is the equivalent capacitance of two 5000 picofarad capacitors and one
750 picofarad capacitor connected in parallel?
A. 576.9 picofarads
B. 1733 picofarads
C. 3583 picofarads
D. 10750 picofarads
```

Capacitors in parallel add like resistors in series. In this case, C_T = (5000 + 5000 + 750) pF = 10750 pF. This computation matches Answer D.

```
G5C09 (C)
What is the capacitance of three 100 microfarad capacitors connected in
series?
A. .30 microfarads
B. .33 microfarads
C. 33.3 microfarads
D. 300 microfarads
```

Capacitors in series add like resistors in parallel. In this case, C_T = 1/(1/100 + 1/100 + 1/100) μF = 33.3 μF. This computation matches Answer C. Be careful with Answer D since it is for capacitors in parallel.

```
G5C10 (C)
What is the inductance of three 10 millihenry inductors connected in parallel?
A. .30 Henrys
B. 3.3 Henrys
C. 3.3 millihenrys
D. 30 millihenrys
```

Inductors in parallel add like resistors in parallel so the total inductance is given by L_T = 1/(1/L1 + 1/L2 + 1/L3) = 1/(1/0.01 + 1/0.01 + 1/0.01) mH = 3.3 mH. This matches the computation in Answer **C**.

G5C11 (C)
What is the inductance of a 20 millihenry inductor in series with a 50 millihenry inductor?
A. .07 millihenrys
B. 14.3 millihenrys
C. 70 millihenrys
D. 1000 millihenrys

Inductors in series add like resistors in series so the total inductance is given by L_T = 20 mH + 50 mH = 70 mH. This corresponds to the computation in Answer C.

G5C12 (B)
What is the capacitance of a 20 microfarad capacitor in series with a 50 microfarad capacitor?
A. .07 microfarads
B. 14.3 microfarads
C. 70 microfarads
D. 1000 microfarads

The total capacitance for parallel capacitors is computed from CT = 1/(1/C1 + 1/C2) = 1/(1/20 + 1/50) μF = 14.3 μF. Answer **B** is the right computation while the other choices have math mistakes.

G5C13 (C)
What component should be added to a capacitor in a circuit to increase the circuit capacitance?
A. An inductor in series
B. A resistor in series
C. A capacitor in parallel
D. A capacitor in series

To increase capacitance, we need to add capacitors so Answers A and B are eliminated. Capacitors in parallel add like resistors in series, therefore, to increase capacitance, we add more capacitors in parallel just as givne in Answer **C**.

G5C14 (D)
What component should be added to an inductor in a circuit to increase the circuit inductance?
A. A capacitor in series
B. A resistor in parallel
C. An inductor in parallel
D. An inductor in series

Inductors add like resistors do. In this case, to increase inductance, we need to add an inductor so we can eliminate Answers A and B. To increase inductance, we add the inductors in series making Answer **D** the correct method. Answer C will decrease the inductance.

G5C15 (A)
What is the total resistance of a 10 ohm, a 20 ohm, and a 50 ohm resistor in parallel?
A. 5.9 ohms
B. 0.17 ohms
C. 10000 ohms
D. 80 ohms

The total resistance will be computed from $R_T = 1/(1/R1 + 1/R2 + 1/R3) = 1/(1/10 + 1/20 + 1/30) = 5.5\ \Omega$. Answer **A** is the closest to this computation so that is the right choice.

```
G5C16 (B)
What component should be added to an existing resistor in a circuit to
increase circuit resistance?
A. A resistor in parallel
B. A resistor in series
C. A capacitor in series
D. A capacitor in parallel
```

To increase resistance, we need to add resistance. This eliminates Answers C and D. To increase resistance, we add the new resistor in series as in Answer **B**. Placing the resistor in parallel, will decrease resistance.

Subelement G6 - Circuit Components

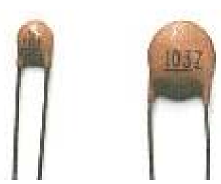
G6A01 (C)
What will happen to the resistance if the temperature of a carbon resistor is increased?
A. It will increase by 20% for every 10 degrees centigrade
B. It will stay the same
C. It will change depending on the resistor's temperature coefficient rating
D. It will become time dependent

Generally, resistors increase in resistance as the temperature increases. The exact amount depends on the resistor's temperature coefficient so Answer **C** is the right choice. Answer A may be the case for a specific device but it is not true in general so this is not a good choice. Answers B and D are to distract you.

G6A02 (D)
What type of capacitor is often used in power-supply circuits to filter the rectified AC?
A. Disc ceramic
B. Vacuum variable
C. Mica
D. Electrolytic

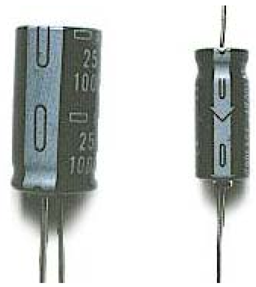
Smoothing rectified AC takes a big capacitor. Of the capacitors listed, the electrolytic allows you to have the highest capacitance in the smallest volume so this is a good choice for a power supply filter. Answer **D** is the best choice of the ones given.

G6A03 (D)
Which of the following is the primary advantage of ceramic capacitors?
A. Tight tolerance
B. High stability
C. High capacitance for given volume
D. Comparatively low cost



Ceramic capacitors generally have low tolerance, low stability, and low capacitance per volume. However, they are inexpensive so Answer **D** is the correct choice.

G6A04 (C)
Which of the following is an advantage of an electrolytic capacitor?
A. Tight tolerance
B. Non-polarized
C. High capacitance for given volume
D. Inexpensive RF capacitor



As mentioned in the previous question, the electrolytic capacitors have high capacitance for a given volume which is why they are frequently used. They are polarized and more expensive than some other types. Answer C is the right choice.

G6A05 (A)
Which of the following is one effect of lead inductance in a capacitor used at VHF and above?
A. Effective capacitance may be reduced
B. Voltage rating may be reduced
C. ESR may be reduced
D. The polarity of the capacitor might become reversed

The lead inductance will be a reactance that tends to oppose the reactance of the capacitor. Therefore, the effective capacitance will be lower and Answer **A** is the right choice. It will not have the effects listed in the other choices.

G6A06 (B)
What is the main disadvantage of using a conventional wire-wound resistor in a resonant circuit?
A. The resistor's tolerance value would not be adequate for such a circuit
B. The resistor's inductance could detune the circuit
C. The resistor could overheat
D. The resistor's internal capacitance would detune the circuit

Wire-wound resistor has significant inductive properties. A tuned circuit is defined by the capacitors and inductors in the rest of the circuit. The wire-wound resistor will interact with these components and can de-tune the circuit so Answer **B** is the right choice. Since the resistor is inductive, Answer D is incorrect. Answers A and C are not what happens with these components.

G6A07 (D)
What is an advantage of using a ferrite core with a toroidal inductor?
A. Large values of inductance may be obtained
B. The magnetic properties of the core may be optimized for a specific range of frequencies
C. Most of the magnetic field is contained in the core
D. All of these choices are correct

Since each of the effects mentioned in Answers A, B, and C are true, Answer **D** is the best choice.

G6A08 (C)
How should two solenoid inductors be placed so as to minimize their mutual inductance?
A. In line with their winding axis
B. With their winding axes parallel to each other
C. With their winding axes at right angles to each another
D. Within the same shielded enclosure

The mutual inductance will be highest if the magnetic field lines are aligned in the same direction. If we wish to minimize this, then we should place the inductors so that their field lines are 90 degrees apart. This makes Answer

C the right choice. Answers A and B will tend to keep the fields aligned so they are not good choices. Answer D keeps the fields confined together so this will also not reduce coupling.

```
G6A09 (B)
Why might it be important to minimize the mutual inductance between two
inductors?
A. To increase the energy transfer between both circuits
B. To reduce or eliminate unwanted coupling
C. To reduce conducted emissions
D. To increase the self-resonant frequency of both inductors
```

Minimizing mutual inductance will decrease energy transfer so Answer A is incorrect. Minimizing the mutual inductance will decrease the coupling as in Answer **B** so this is the correct choice. Answer C is technobabble. Answer D is not what is relevant here.

```
G6A10 (B)
What is an effect of inter-turn capacitance in an inductor?
A. The magnetic field may become inverted
B. The inductor may become self resonant at some frequencies
C. The permeability will increase
D. The voltage rating may be exceeded
```

The addition of the right capacitance will actually make the inductor resonant at certain frequencies. This makes Answer **B** the correct choice. The other choices will not occur by the capacitance effects so do not choose them.

```
G6A11 (D)
What is the common name for a capacitor connected across a transformer
secondary that is used to absorb transient voltage spikes?
A. Clipper capacitor
B. Trimmer capacitor
C. Feedback capacitor
D. Suppressor capacitor
```

While there are many capacitor applications in circuit analysis, this particular application is so named because the capacitor suppresses the voltage spikes which makes Answer **D** the correct choice.

```
G6A12 (D)
What is the common name for an inductor used to help smooth the DC output from
the rectifier in a conventional power supply?
A. Back EMF choke
B. Repulsion coil
C. Charging inductor
D. Filter choke
```

This particular inductor “chokes” the undesired signals so this is called a filter choke as in Answer **D**.

G6A13 (B)
What type of component is a thermistor?
A. A resistor that is resistant to changes in value with temperature variations
B. A device having a controlled change in resistance with temperature variations
C. A special type of transistor for use at very cold temperatures
D. A capacitor that changes value with temperature

A thermistor is a resistor that is specially designed to change with temperature so Answer **B** is the correct choice. Answer A is a good device but it is not a thermistor so do not make this choice. It is not a transistor or capacitor so Answers C and D are to distract you.

G6B01 (C)
What is the peak-inverse-voltage rating of a rectifier?
A. The maximum voltage the rectifier will handle in the conducting direction
B. 1.4 times the AC frequency
C. The maximum voltage the rectifier will handle in the non-conducting direction
D. 2.8 times the AC frequency

If it is the inverse voltage, then the rectifier is operating in the non-conducting direction. The PIV is the peak voltage in this mode so Answer **C** is the right choice. The other choices are to see if you know how PIV is defined.

G6B02 (A)
What are the two major ratings that must not be exceeded for silicon-diode rectifiers?
A. Peak inverse voltage; average forward current
B. Average power; average voltage
C. Capacitive reactance; avalanche voltage
D. Peak load impedance; peak voltage

The peak inverse voltage and average forward current are two ratings that deal with the operational characteristics of a diode so Answer **A** is the right choice. The other choices are not typical diode ratings so do not choose them.

G6B03 (B)
What is the approximate junction threshold voltage of a germanium diode?
A. 0.1 volt
B. 0.3 volts
C. 0.7 volts
D. 1.0 volts

This is one of those items you may need to memorize. For germanium diodes, the voltage is 0.3 V as in Answer **B**. Be careful because 0.7 V is found in many silicon diodes. The other choices are there to distract you.

G6B04 (C)
When two or more diodes are connected in parallel to increase current handling capacity, what is the purpose of the resistor connected in series with each diode?
A. The resistors ensure the thermal stability of the power supply
B. The resistors regulate the power supply output voltage
C. The resistors ensure that one diode doesn't carry most of the current
D. The resistors act as swamping resistors in the circuit

A forward-biased diode will have very small resistance and allow current to conduct. When two diodes are connected in parallel, the internal resistance in each diode will not match exactly so one will tend to carry all of the current and then it could violate forward current capacity. To prevent this, resistance is added in series to each diode making Answer **C** the correct choice. The other choices have nothing to do with these resistors.

G6B05 (C)
What is the approximate junction threshold voltage of a silicon diode?
A. 0.1 volt
B. 0.3 volts
C. 0.7 volts
D. 1.0 volts

Back to diode voltages. We saw that Answer B was for germanium diodes so it is not the right choice here. The silicon diodes need 0.7 V so Answer **C** is the right choice. Answers A and D are to distract you.

G6B06 (A)
Which of the following is an advantage of using a Schottky diode in an RF switching circuit as compared to a standard silicon diode?
A. Lower capacitance
B. Lower inductance
C. Longer switching times
D. Higher breakdown voltage

A Schottky diode is known for quick switching time so Answer C is incorrect. Diodes have capacitive components so Answer B is incorrect. You need to remember that lower capacitance in Answer **A** is the right choice.

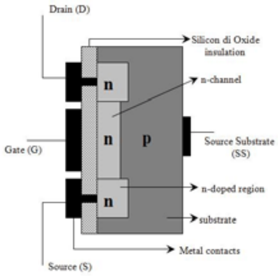
G6B07 (A)
What are the stable operating points for a bipolar transistor that is used as a switch in a logic circuit?
A. Its saturation and cut-off regions
B. Its active region (between the cut-off and saturation regions)
C. Between its peak and valley current points
D. Between its enhancement and deletion modes

Bipolar transistor switches are run to either saturation or cutoff so Answer **A** is the right choice. Answer B is the normal amplifier region and not the switch operating mode. Answers C and D are to distract you.

G6B08 (D)
Why is it often necessary to insulate the case of a large power transistor?
A. To increase the beta of the transistor
B. To improve the power dissipation capability
C. To reduce stray capacitance
D. To avoid shorting the collector or drain voltage to ground

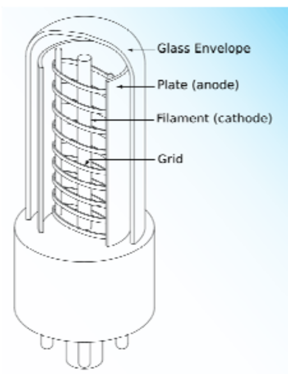
This will not improve the beta (a gain factor) of the transistor so Answer A is incorrect. Power transistors often have heat dissipation problems but this will not affect heat so Answer B is also incorrect. It does not get rid of stray capacitances so Answer C is incorrect. The correct reasoning is found in Answer **D**.

G6B09 (B)
Which of the following describes the construction of a MOSFET?
A. The gate is formed by a back-biased junction
B. The gate is separated from the channel with a thin insulating layer
C. The source is separated from the drain by a thin insulating later
D. The source is formed by depositing metal on silicon



The question does not specify the exact type of MOSFET so we will use the graphic as a representation. As you can see, the gate is separated from the n-channel by a layer of silicon dioxide which is an insulator. This makes Answer **B** the correct choice. From the figure, we can see that Answer C does not match the geometry. Answers A is for a JFET and D does not correspond to the MOSFET construction method.

G6B10 (A)
Which element of a triode vacuum tube is used to regulate the flow of electrons between cathode and plate?
A. Control grid
B. Heater
C. Screen Grid
D. Suppressor grid



The triode vacuum tube is illustrated in the graphic. The control grid is the regulator of electron flow so Answer **A** is the right choice. The other elements mentioned are not part of a triode tube.

G6B11 (B)
Which of the following solid state devices is most like a vacuum tube in its general characteristics?
A. A bipolar transistor
B. An FET
C. A tunnel diode
D. A varistor

The best choice is a FET as in Answer **B** because it uses an electric field to control the flow of electrons similar to what is found in a vacuum tube. Be careful with Answer A because bipolar transistors can be used like a vacuum tube in some instances. The other choices are not like tubes.

G6B12 (A)
What is the primary purpose of a screen grid in a vacuum tube?
A. To reduce grid-to-plate capacitance
B. To increase efficiency
C. To increase the high frequency response
D. To decrease plate resistance

The screen grid was added to vacuum tubes to reduce the grid-to-plate capacitance so Answer **A** is the right choice. The other choices are to distract you.

G6B13 (B)
What is an advantage of the low internal resistance of Nickel Cadmium batteries?
A. Long life
B. High discharge current
C. High voltage
D. Rapid recharge

The internal resistance of a battery will limit the ability to supply high current so Answer **B** is the right choice. It will not extend life, increase the voltage, or allow a rapid recharge so do not choose those answers.

G6B14 (C)
What is the minimum allowable discharge voltage for maximum life of a standard 12 volt lead acid battery?
A. 6 volts
B. 8.5 volts
C. 10.5 volts
D. 12 volts

This question is asking about general operating conditions for standard 12-V batteries. The loaded voltage at full discharge is 10.5 V so Answer **C** is the right choice.

G6B15 (D)
When is it acceptable to recharge a carbon-zinc primary cell?
A. As long as the voltage has not been allowed to drop below 1.0 volt
B. When the cell is kept warm during the recharging period
C. When a constant current charger is used
D. Never

This is the standard consumer battery and it should never be recharged so Answer **D** is the right choice.

G6B16 (C)
Which of the following is a rechargeable battery?
A. Carbon-zinc
B. Silver oxide
C. Nickel Metal Hydride
D. Mercury

We just saw that carbon-zinc is not rechargeable so Answer A is eliminated. Nickel Metal Hydride is rechargeable so Answer **C** is the correct choice. The others are to distract you.

G6C01 (D)
Which of the following is most often provided as an analog integrated circuit?
A. NAND Gate
B. Gallium Arsenide UHF Receiver "front end" Amplifier
C. Frequency Counter
D. Linear voltage regulator

A NAND gate and a frequency counter are not analog integrated circuits so Answers A and C are eliminated. A linear voltage regulator is a very common analog IC so Answer **D** is the best choice. In the future, Answer B may also be a common choice as well.

G6C02 (C)
Which of the following is the most commonly used digital logic family of integrated circuits?
A. RTL
B. TTL
C. CMOS
D. PMOS

Resistor-Transistor Logic, Transistor-Transistor Logic, and Complementary Metal Oxide Semiconductor have all been used for logic families. The question is asking for the most common now. In the past few years, CMOS has overtaken TTL making Answer C the right choice.

G6C03 (A)
Which of the following is an advantage of CMOS Logic integrated circuits compared to TTL logic circuits?
A. Low power consumption
B. High power handling capability
C. Better suited for RF amplification
D. Better suited for power supply regulation

The main reason CMOS has overtaken TTL is because of its relatively low power consumption so Answer **A** is the correct choice. The other choices are necessarily true for CMOS.

G6C04 (B)
What is meant by the term ROM?
A. Resistor Operated Memory
B. Read Only Memory
C. Random Operational Memory
D. Resistant to Overload Memory

You should be able to spot Read Only Memory in Answer **B** as the correct answer. The others are silly distractions.

G6C05 (C)
What is meant when memory is characterized as "non-volatile"?
A. It is resistant to radiation damage
B. It is resistant to high temperatures
C. The stored information is maintained even if power is removed
D. The stored information cannot be changed once written

Non-volatile memory retains its contents when power is removed so Answer **C** is the correct choice. The other choices are not described as non-volatile.

G6C06 (D)
Which type of integrated circuit is an operational amplifier?
A. Digital
B. MMIC
C. Programmable
D. Analog

The operational amplifier is an analog IC so Answer **D** is correct. It is not digital so Answer A is eliminated, it is not programmable so Answer C is also eliminated. A MMIC is a multi-component IC module.

G6C07 (D)
What is one disadvantage of an incandescent indicator compared to a LED?
A. Low power consumption
B. High speed
C. Long life
D. High power consumption

LED's are low-power devices while incandescent lamps take relatively high power. This makes Answer **D** the correct choice.

G6C08 (D)
How is an LED biased when emitting light?
A. Beyond cutoff
B. At the Zener voltage
C. Reverse Biased
D. Forward Biased

A LED "turns on" when it is forward biased which makes Answer **D** the correct choice. LED's work like regular diodes when in reverse bias mode. Zener diodes are their own special category and they are not used as LED's.

G6C09 (A)
Which of the following is a characteristic of a liquid crystal display?
A. It requires ambient or back lighting
B. It offers a wide dynamic range
C. It has a wide viewing angle
D. All of these choices are correct

A LCD does not have a wide viewing angle nor does it have a wide dynamic range. Since Answers B and C are incorrect, Answer D is also incorrect. The LCD does require backlighting so Answer **A** is the correct choice.

G6C10 (B)
What is meant by the term MMIC?
A. Multi Megabyte Integrated Circuit
B. Monolithic Microwave Integrated Circuit
C. Military-specification Manufactured Integrated Circuit
D. Mode Modulated Integrated Circuit

MMIC is an acronym for Monolithic Microwave Integrated Circuit which makes Answer **B** the right choice. The other choices are silly distractions to confuse you.

G6C11 (B)
What is a microprocessor?
A. A low powered analog signal processor used as a microwave detector
B. A miniature computer on a single integrated circuit chip
C. A microwave detector, amplifier, and local oscillator on a chip
D. A low voltage amplifier used in a microwave transmitter modulator stage

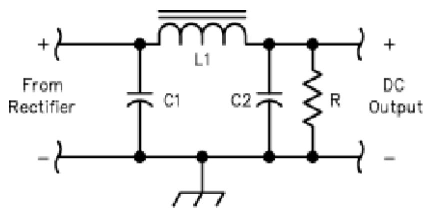
The correct definition of a microprocessor is given in Answer **B**. The others are various analog modules.

G6C12 (A)
What two devices in an amateur radio station might be connected using a USB interface?
A. Computer and transceiver
B. Microphone and transceiver
C. Amplifier and antenna
D. Power supply and amplifier

A USB interface is a serial data interface. Of the choices given, connecting a computer and a transceiver is the most common use so Answer **A** is the correct choice. Answers C and D would never be done because USB is a low-power interface. Answer B might be possible soon but is not common today.

Subelement G7 - Practical Circuits

G7A01 (B)
What safety feature does a power-supply bleeder resistor provide?
A. It acts as a fuse for excess voltage
B. It discharges the filter capacitors
C. It removes shock hazards from the induction coils
D. It eliminates ground-loop current



If you read the question carefully, answers B and C seem to be the best candidates since they deal with safety issues. The bleeder will not provide the electrical functions given in answers A and D so they are eliminated. The electrical purpose of the bleeder resistor is given in answer **B** so that is the right answer. Answer C is not true so it is a bad choice.

G7A02 (D)
What components are used in a power-supply filter network?
A. Diodes
B. Transformers and transistors
C. Quartz crystals
D. Capacitors and inductors

Power supply filters are built with capacitors and inductors so answer **D** is the correct choice. Diodes do not provide filtering action so answer A is eliminated. Transistors are also not used in filters so answer B is out. Crystals can be used in signal processing filters but not in power supply filters so answer C is not a correct choice either.

G7A03 (C)
What should be the minimum peak-inverse-voltage rating of the rectifier in a full-wave power supply?
A. One-quarter the normal output voltage of the power supply
B. Half the normal output voltage of the power supply
C. Double the normal peak output voltage of the power supply
D. Equal to the normal output voltage of the power supply

This is a “rule of thumb” question and you need to remember that a full-wave rectifier needs a diode with at least double the peak voltage for proper design (it always needs more than the output voltage level). Therefore, answer **C** is the best choice. Answer D will not provide an adequate design margin so it is eliminated. Answers A and B are less than the input voltage so the diodes with these voltage ratings can be damaged (let the smoke out) and should not be used.

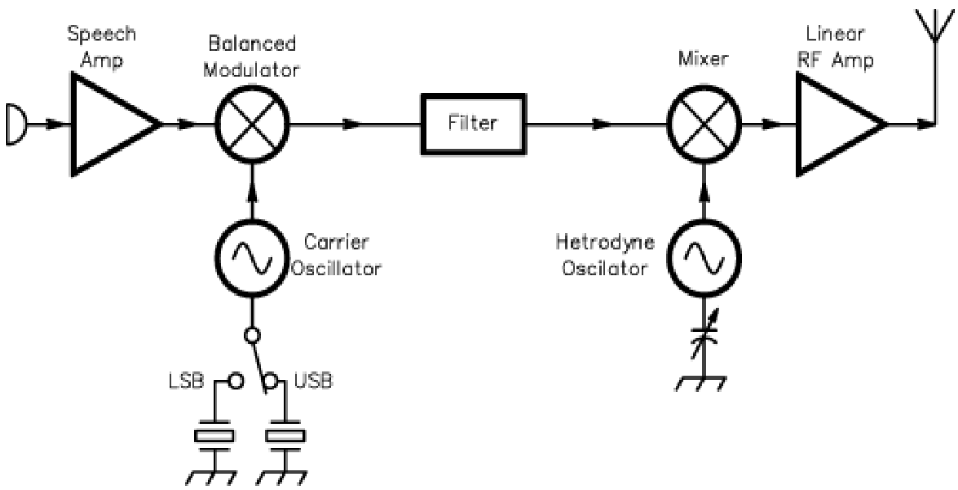
G7A04 (D)
What should be the approximate minimum peak-inverse-voltage rating of the rectifier in a half-wave power supply?
A. One-half the normal peak output voltage of the power supply
B. Half the normal output voltage of the power supply
C. Equal to the normal output voltage of the power supply
D. Two times the normal peak output voltage of the power supply

This is another “rule of thumb” question and, based on the last question, we can eliminate answers A, B, and C since they violate the design rule and are not greater than the output voltage. Therefore, answer **D** is the best choice.

G7A05 (B)
What should be the impedance of a low-pass filter as compared to the impedance of the transmission line into which it is inserted?
A. Substantially higher
B. About the same
C. Substantially lower
D. Twice the transmission line impedance

From our knowledge of maximum power transfer, we get best results when the impedances are matched so answer **B** is the best choice. All other choices will not result in optimal power transfer so they are not good choices.

G7A06 (B)
Which of the following might be used to process signals from the balanced modulator and send them to the mixer in a single-sideband phone transmitter?
A. Carrier oscillator
B. Filter
C. IF amplifier
D. RF amplifier

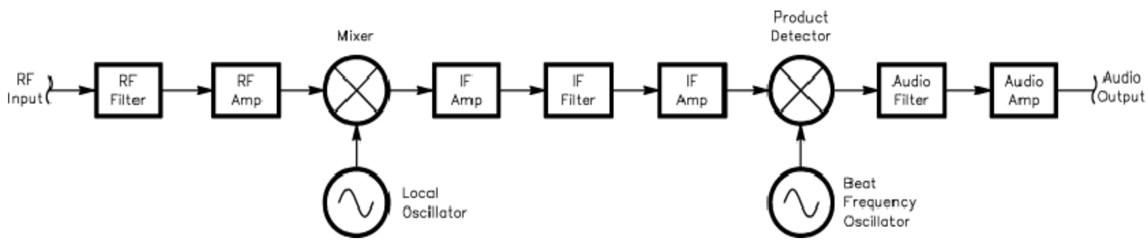


In a typical SSB transmitter, the carrier oscillator of answer A is one of the inputs to the balanced modulator along with the audio signal so this is not a good choice for the correct answer because the question deals with the output of the balanced modulator. The RF amplifier of choice D is one of the last components of the transmitter and there needs to be some signal processing prior to this stage. This signal processing occurs in the middle of the transmitter. You need to remember that the correct name for this component is the filter as in answer **B**. Generally, an IF amplifier is found in a receiver and not a transmitter so answer C is not a good choice here.

G7A07 (D)
Which circuit is used to combine signals from the carrier oscillator and speech amplifier and send the result to the filter in a typical single-sideband phone transmitter?
A. Mixer
B. Detector
C. IF amplifier
D. Balanced modulator

Since we are still dealing with the SSB transmitter, we can eliminate the two components found in receivers as answers for this question. The detector is in the receiver so answer B can be eliminated here. Again, the IF amplifier is a receiver component so answer C can also be eliminated. You need to remember that the balanced modulator from answer **D** is the right component since it take the audio signal and the carrier signal and combines them. Be careful with answer A because this process if often called a “mixing” process. Generally, the term mixer will be used for devices that change the location of a signal in the frequency spectrum.

G7A08 (C)
What circuit is used to process signals from the RF amplifier and local oscillator and send the result to the IF filter in a superheterodyne receiver?
A. Balanced modulator
B. IF amplifier
C. Mixer
D. Detector



Since we have now moved to the receiver, we can eliminate the transmitter component which is the balanced modulator in answer A. The detector is the last stage in the receiver process so answer D is eliminated. The question is asking which component translates the signals from the RF stage down to the IF stage in the receiver. The mixer, as in answer **C,** will have RF and local oscillator signals as its input and send its output to the IF filter. The IF amplifier in answer B comes after this stage.

G7A09 (D)
What circuit is used to process signals from the IF amplifier and BFO and send the result to the AF amplifier in a single-sideband phone superheterodyne receiver?
A. RF oscillator
B. IF filter
C. Balanced modulator
D. Product detector

We are still looking at the operation of the receiver here so we can eliminate the balanced modulator of answer C and the RF oscillator of answer A. This is near the last stage in the receiver process because we wish to amplify the audio frequency (AF) signals next. The detector in answer **D** is the correct choice since it has the IF and BFO signals for inputs and an audio-type signal for the output. Answer B comes prior to this stage so it can be eliminated as well.

G7A10 (A)
What is an advantage of a crystal controlled transmitter?
A. Stable output frequency
B. Excellent modulation clarity
C. Ease of switching between bands
D. Ease of changing frequency

The use of crystals is to give a highly stable output frequency so Answer **A** is the correct choice. The other choices are not highly dependent on the use of a crystal over other components.

```
G7A11 (C)
What is the simplest combination of stages that can be combined to implement a
superheterodyne receiver?
A. RF amplifier, detector, audio amplifier
B. RF amplifier, mixer, if amplifier
C. HF oscillator, mixer, detector
D. HF oscillator, product detector, audio amplifier
```

To make a receiver you must have a detector stage present so Answer B is eliminated. The detector normally does not operate at HF frequencies so a RF amplifier alone will not make a good receiver so Answers A and B are eliminated. Both Answers C and D have HF oscillators that will assist in bringing the HF signal down to be detected. However, without a mixer, we will not be able to bring the signals to the detector. This makes Answer **C** the best choice. Answer D will not be able to bring the signals into the detector so this is not a good choice.

```
G7A12 (D)
What type of receiver is suitable for CW and SSB reception but does not
require a mixer stage or an IF amplifier?
A. A super-regenerative receiver
B. A TRF receiver
C. A super-heterodyne receiver
D. A direct conversion receiver
```

All of the choices in Answers A, B, and C require a mixer stage or IF amplifier so they are not correct choices. The direct conversion receiver of Answer **D** is the correct choice.

```
G7A13 (D)
What type of circuit is used in many FM receivers to convert signals coming
from the IF amplifier to audio?
A. Product detector
B. Phase inverter
C. Mixer
D. Discriminator
```

Many FM receivers use discriminators to convert from the IF to audio. This makes Answer **D** the right choice. FM is not detected by any of the choices in Answers A, B, or C. They are used in various AM processes.

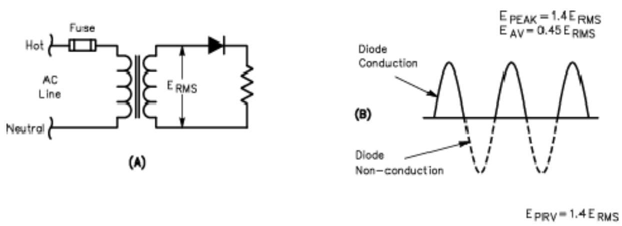
```
G7A14 (A)
Which of the following is a desirable characteristic for capacitors used to
filter the DC output of a switching power supply?
A. Low equivalent series resistance
B. High equivalent series resistance
C. Low Temperature coefficient
D. High Temperature coefficient
```

The temperature coefficients will not do the electrical job required so answers C and D are eliminated from consideration. If they have high series resistance, then output power will be dissipated in that resistance which is generally not desirable. Low series resistance will keep from losing too much power and Answer **A** is the right choice.

G7A15 (C)
Which of the following is an advantage of a switched-mode power supply as compared to a linear power supply?
A. Faster switching time makes higher output voltage possible
B. Fewer circuit components are required
C. High frequency operation allows the use of smaller components
D. All of these choices are correct

Choices A and B are incorrect statements for switched-mode supplies. This makes answer D also incorrect. Answer **C** is the correct statement about switched-mode power supplies.

G7A16(B)
What portion of the AC cycle is converted to DC by a half-wave rectifier?
A. 90 degrees
B. 180 degrees
C. 270 degrees
D. 360 degrees

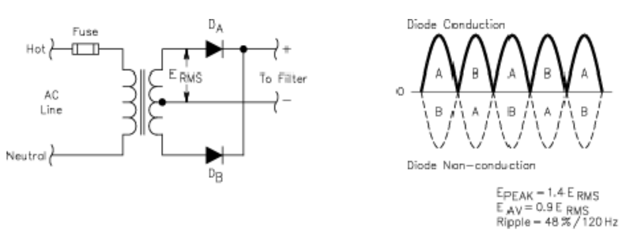


It is called half-wave because it conducts over ½ the cycle or 180 degrees so the correct choice is answer **B**. Answer D is full wave so it is out. Answers A and C are not connected with wave rectifiers at all.

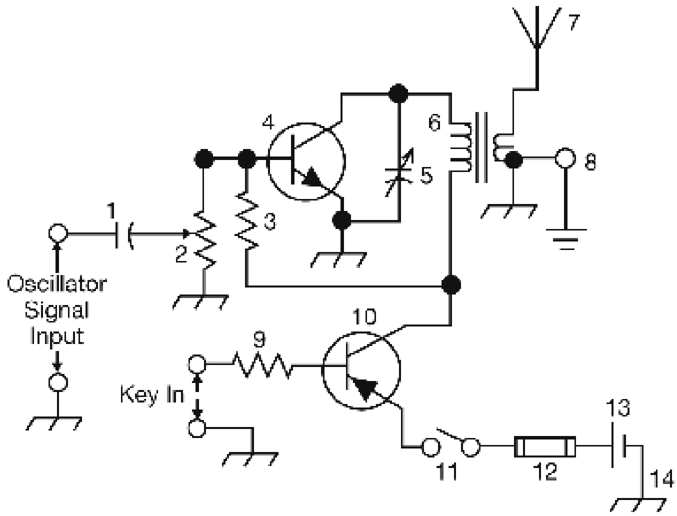
G7A17 (D)
What portion of the AC cycle is converted to DC by a full-wave rectifier?
A. 90 degrees
B. 180 degrees
C. 270 degrees
D. 360 degrees

Based on the last answer, you should be able to spot the correct answer as **D**. Answer B is for the half-wave rectifier while answers A and C are eliminated from consideration since rectifiers do not conduct in these phase modes.

G7A18 (A)
What is the output waveform of an unfiltered full-wave rectifier connected to a resistive load?
A. A series of DC pulses at twice the frequency of the AC input
B. A series of DC pulses at the same frequency as the AC input
C. A sine wave at half the frequency of the AC input
D. A steady DC voltage



You need to remember that a full-wave rectifier produces pulses at twice the frequency of the AC input because it takes the negative-half signal and makes it positive thereby producing two pulses per cycle. So answer **A** is the right choice. Answer B is for a half-wave rectifier so it is eliminated. Answers C and D do not describe how rectifiers work so they are eliminated as well.



G7A19 (C)
Which symbol in figure G7-1 represents a fixed resistor?
A. Symbol 2
B. Symbol 6
C. Symbol 3
D. Symbol 12

Symbol 2 is a variable resistor, Symbol 6 is a transformer, Symbol 3 is a fixed resistor, and Symbol 12 is a fuse. This makes Answer **C** the correct choice.

G7A20 (D)
Which symbol in figure G7-1 represents a single cell battery?
A. Symbol 5
B. Symbol 12
C. Symbol 8
D. Symbol 13

Symbol 5 is a variable capacitor, Symbol 8 is a test point, Symbol 10 is a fuse, and Symbol 13 is a single cell battery. This makes Answer **D** the correct choice.

G7A21 (B)
Which symbol in figure G7-1 represents a NPN transistor?
A. Symbol 2
B. Symbol 4
C. Symbol 10
D. Symbol 12

Symbol 2 is a variable resistor, Symbol 4 is a NPN transistor, Symbol 10 is a PNP transistor, and Symbol 12 is a fuse. This makes Answer **B** the correct choice.

G7A22 (C)
Which symbol in figure G7-1 represents a variable capacitor?
A. Symbol 2
B. Symbol 11
C. Symbol 5
D. Symbol 12

Symbol 2 is a variable resistor, Symbol 5 is a variable capacitor, Symbol 11 is a single-pole switch, and Symbol 12 is a fuse. This makes Answer **C** the correct choice.

```
G7A23  (A)
Which symbol in figure G7-1 represents a transformer?
A. Symbol 6
B. Symbol 4
C. Symbol 10
D. symbol 2
```

Symbol 2 is a variable resistor, Symbol 4 is a NPN transistor, Symbol 6 is a transformer, and Symbol 10 is a PNP transistor. This makes Answer **A** the correct choice.

```
G7A24 (C)
Which symbol in figure G7-1 represents a single pole switch?
A. Symbol 2
B. Symbol 3
C. Symbol 11
D. Symbol 12
```

Symbol 2 is a variable resistor, Symbol 3 is a fixed resistor, Symbol 11 is a single-pole switch, and Symbol 12 is a fuse. This makes Answer **C** the correct choice.

```
G7B01 (B)
Which of the following describes a "flip-flop" circuit?
A. A transmit-receive circuit
B. A digital circuit with two stable states
C. An RF limiter
D. A voice-operated switch
```

The correct definition of a flip-flop is given in Answer **B**: a digital circuit with two stable states. Answer D is a VOX circuit. The others are not digital circuits so they are also incorrect choices.

```
G7B02 (A)
Why do digital circuits use the binary number system?
A. Binary "ones" and "zeros" are easy to represent with an "on" or "off" state
B. The binary number system is most accurate
C. Binary numbers are more compatible with analog circuitry
D. All of these answers are correct
```

Answer B is incorrect – any number system is as accurate as another. Answer C is incorrect – analog looks at a range of possibilities and not just two. Since Answers B and C are incorrect, Answer D is also eliminated. The correct reasoning is given in Answer **A**.

```
G7B03 (C)
What is the output of a two-input NAND gate, given both inputs are "one"?
A. Two
B. One
C. Zero
D. Minus One
```

Digital logic circuits can have either zero or one on the input and the output. This means that Answers C and D cannot be correct. The input/output relationship for a NAND gate are given in the table below. From this, we can see that the zero in Answer **C** is the right choice.

Input 1	Input 2	NAND Output
0	0	0
0	1	0
1	0	0
1	1	1

```
G7B04 (B)
What is the output of a NOR gate given that both inputs are "zero"?
A. Zero
B. One
C. Minus one
D. The opposite from the previous state
```

Another question on digital logic circuits. Again, Answer C cannot be correct. The input/output relationship for a NOR gate are given in the table below. From this, we can see that the one in Answer **B** is the right choice.

Input 1	Input 2	NOR Output
0	0	1
0	1	0
1	0	0
1	1	0

```
G7B05 (C)
How many states are there in a 3-bit binary counter?
A. 3
B. 6
C. 8
D. 16
```

The “3-bit” refers to the number of inputs. The number of states is $2^3 = 8$. This makes Answer **C** the correct computation. The others are math mistakes.

```
G7B06 (A)
What is a shift register?
A. A clocked array of circuits that passes data in steps along the array
B. An array of operational amplifiers used for tri-state arithmetic operations
C. A digital mixer
D. An analog mixer
```

A shift register is not a form of mixer so Answers C and D are eliminated from consideration. A shift register does not use operational amplifiers so Answer B is also eliminated. The correct definition of a shift register is given in Answer **A**.

G7B07 (D)
What are the basic components of virtually all oscillators?
A. An amplifier and a divider
B. A frequency multiplier and a mixer
C. A circulator and a filter operating in a feed-forward loop
D. A filter and an amplifier operating in a feedback loop

There are many types of oscillators but the one thing they all have in common is a form of feedback loop. This makes Answer **D** easy to spot as the right choice.

G7B08 (C)
What determines the frequency of an RC oscillator?
A. The ratio of the capacitors in the feedback loop
B. The value of the inductor in the tank circuit
C. The phase shift of the RC feedback circuit
D. The gain of the amplifier

Answers A and B sound god but they are technobabble so they are eliminated from consideration. The amplifier in the oscillator needs to have some gain but it does not control the frequency so Answer D is incorrect. The correct reasoning is given in Answer **C**.

G7B09 (C)
What determines the frequency of an LC oscillator?
A. The number of stages in the counter
B. The number of stages in the divider
C. The inductance and capacitance in the tank circuit
D. The time delay of the lag circuit

A LC oscillator does not have counters and dividers so Answers A and B can be eliminated from consideration. The electrically-correct reasoning is the values of the L and C in the tank circuit so Answer **C** is the correct choice.

G7B10 (D)
Which of the following is a characteristic of a Class A amplifier?
A. Low standby power
B. High Efficiency
C. No need for bias
D. Low distortion

A Class A amplifier is very linear so it should have low distortion making Answer **D** the correct choice. It is not high efficiency so Answer B is incorrect. The others are to distract you.

G7B11 (B)
For which of the following modes is a Class C power stage appropriate for amplifying a modulated signal?
A. SSB
B. CW
C. AM
D. All of these answers are correct

The Class C amplifier can lead to a great deal of distortion in the output so Answers A and C are not good choices – the phone emissions may become distorted as well. By proper construction, a narrow sinusoidal pulse can be transmitted with minimal distortion so it makes this a candidate for CW transmission so Answer **B** is the best choice of those listed here. Answer D cannot be correct.

G7B12 (A)
Which of the following is an advantage of a Class C amplifier?
A. High efficiency
B. Linear operation
C. No need for tuned circuits
D. All of these answers are correct

A Class C amplifier is known as a highly-efficient amplifier. This makes Answer **A** the right choice. It is not linear like a Class A amplifier so Answer B is incorrect. Since B is incorrect, Answer D is also wrong.

G7B13 (B)
How is the efficiency of an RF power amplifier determined?
A. Divide the DC input power by the DC output power
B. Divide the RF output power by the DC input power
C. Multiply the RF input power by the reciprocal of the RF output power
D. Add the RF input power to the DC output power

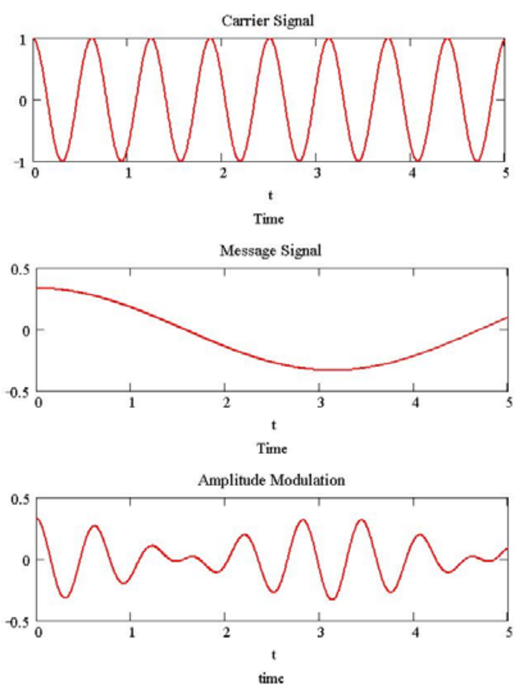
Efficiency is typically determined by taking the ratio of the desired output to the supplied input. This means that we can eliminate Answers C and D. Since this is a RF efficiency, we look for the one with RF power on the output side which corresponds to Answer **B**. Answer A does not have the correct parameters in the ratio.

G7B14 (B)
Which of the following describes a linear amplifier?
A. Any RF power amplifier used in conjunction with an amateur transceiver
B. An amplifier whose output preserves the input waveform
C. A Class C high efficiency amplifier
D. An amplifier used as a frequency multiplier

A linear amplifier preserves the input waveform so Answer **B** is the right choice. Answer A is not a good choice since we do not know the type of amplifier. Answer C is a non-linear amplifier so that is not a good choice. Answer D is technobabble.

Subelement G8 - Signals and Emissions

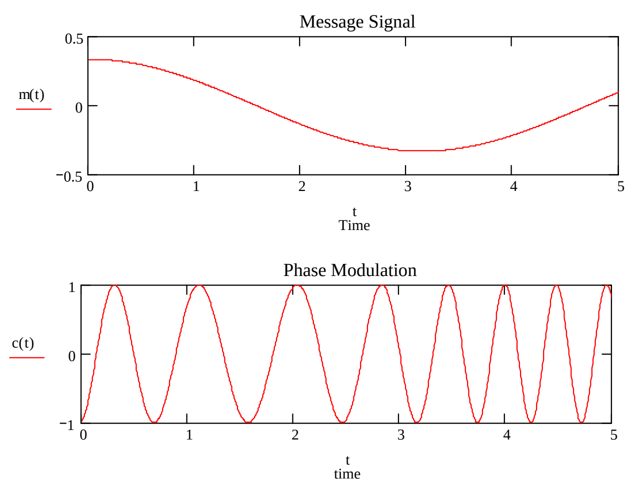
G8A01 (D)
What is the name of the process that changes the envelope of an RF wave to convey information?
A. Phase modulation
B. Frequency modulation
C. Spread Spectrum modulation
D. Amplitude modulation



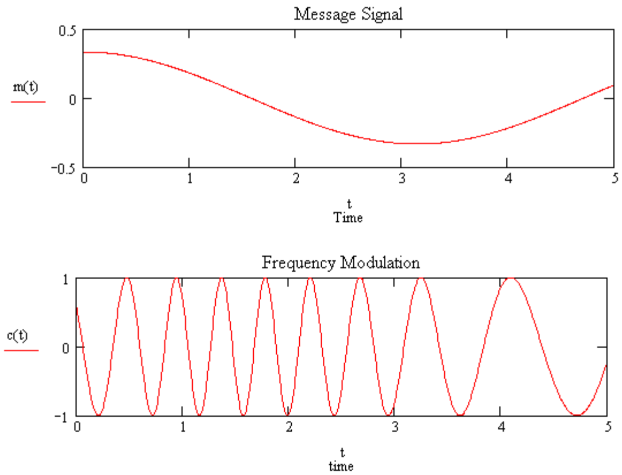
Here we have several questions covering the names for modulation types. If you read the question carefully, you should be able to spot the answer quickly. Prior to modulation, the carrier signal can be written as *Acos*(Θ). Since we are changing envelope of the carrier, we are changing the carrier's amplitude, *A*, as shown in the graphic. This means that we have amplitude modulation – clever those engineers! The correct choice is **D**. Frequency modulation and phase modulation do not modify the carrier's amplitude. Spread spectrum is a special form of either digital phase modulation or digital frequency modulation.

G8A02 (B)
What is the name of the process that changes the phase angle of an RF wave to convey information?
A. Phase convolution
B. Phase modulation
C. Angle convolution
D. Radian Inversion

Another clever name here. Like the previous question, the carrier signal can be written as *Acos*(Θ) prior to modulation. If we change the phase of the carrier, Θ, in response to the message signal as shown in the graphic then we must have phase modulation or answer **B**. Again, watch out for something that looks close. Answer A has phase in it but there is no such thing as phase convolution modulation. Answers C and D are technobabble.



G8A03 (D)
What is the name of the process which changes the frequency of an RF wave to convey information?
A. Frequency convolution
B. Frequency transformation
C. Frequency conversion
D. Frequency modulation



One more time with the names here. Again, the carrier signal can be written as *Acos*(Θ) prior to modulation. The time rate of change in the carrier phase is called the carrier frequency. If we change the frequency in response to the message, we must have frequency modulation or answer **D**. Again, watch out for something that looks close but is wrong.

G8A04 (B)
What emission is produced by a reactance modulator connected to an RF power amplifier?
A. Multiplex modulation
B. Phase modulation
C. Amplitude modulation
D. Pulse modulation

You need to remember that a reactance modulator will produce phase modulation so the best answer among these choices is Answer **B**. Answer A is not a recognized form of modulation so it is eliminated. AM and pulse modulation are produced by different type of modulators so those answers are out as well.

G8A05 (D)
What type of transmission varies the instantaneous power level of the RF signal to convey information?
A. Frequency shift keying
B. Pulse modulation
C. Frequency modulation
D. Amplitude modulation

This is a re-statement of the earlier AM question. This is just stating that the RF envelope is modified in response to the input signal which is a form of AM so Answer **D** is the right choice. FM and FSK usually maintain constant RF envelope power so these are incorrect choices. Pulse modulation uses digital pulses and not instantaneous changes.

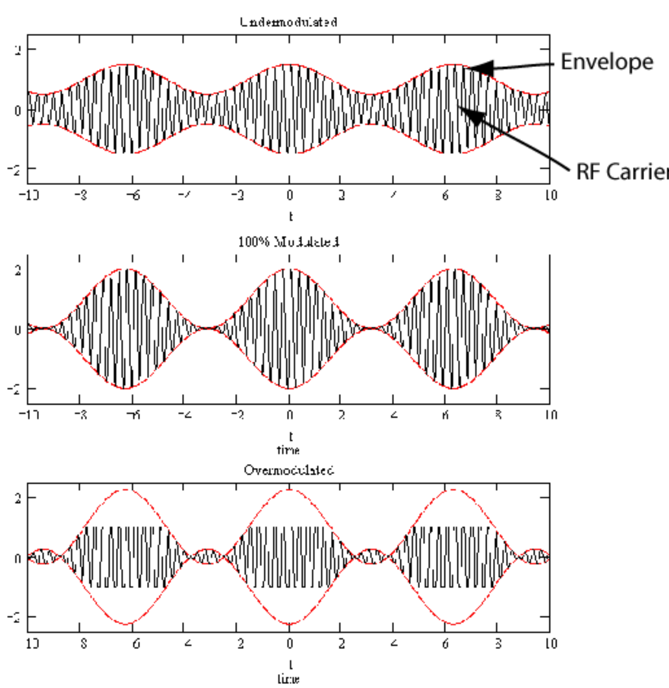
G8A06 (C)
What is one advantage of carrier suppression in a single-sideband phone transmission?
A. Audio fidelity is improved
B. Greater modulation percentage is obtainable with lower distortion
C. More transmitter power can be put into the remaining sideband
D. Simpler receiving equipment can be used

The carrier is a narrow-band signal away from the side band so removing it will not directly affect audio fidelity. It will also not affect modulation percentage. It certainly does not lead to simpler receiving equipment. Only Answer **C** is a correct statement.

G8A07 (A)
Which of the following phone emissions uses the narrowest frequency bandwidth?
A. Single sideband
B. Double sideband
C. Phase modulation
D. Frequency modulation

Here we need to remember the relative bandwidths of the modulation format. Single side band takes about the same bandwidth as the voice signal itself around 3 to 4 kHz. Double side band takes twice this amount. PM and FM usually take around 5 times the SSB amount. Therefore, the correct answer is **A**.

G8A08 (D)
What happens to the signal of an over-modulated single-sideband phone transmitter?
A. It becomes louder with no other effects
B. It occupies less bandwidth with poor high frequency response
C. It has higher fidelity and improved signal to noise ratio
D. It becomes distorted and occupies more bandwidth

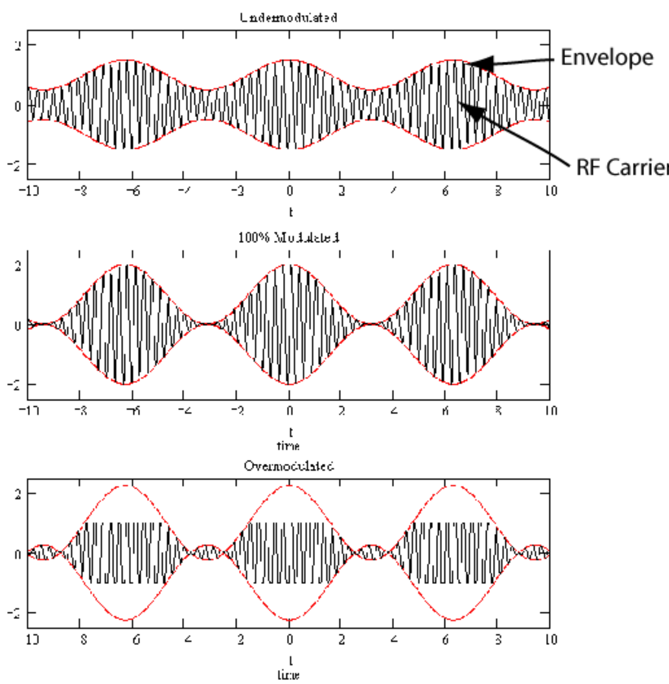


Amplitude-modulated transmissions are often detected using techniques that do not exactly track the amplitude and phase of the incoming signal making it important to keep the signal envelope intact. Because of this, the signal needs to be kept below the 100% modulation level as in the first two panels of the graphic. Overmodulation produces a distorted signal which is shown in the third panel of the graphic where there is a small bump in the signal envelope between the large humps and the RF carrier does not fill the envelope due to amplitude clipping circuits that cause "flat topping" in the carrier. These effects distort the signal. This makes answer **D** is the best choice. Answer A is untrue so it is eliminated. Answer B is untrue because overmodulation produces signal splatter making the occupied bandwidth larger than the correctly-modulated case. Answer C is wrong because the overmodulated signal has a degree of distortion to it.

G8A09 (B)
What control is typically adjusted for proper ALC setting on an amateur single sideband transceiver?
A. The RF Clipping Level
B. Audio or microphone gain
C. Antenna inductance or capacitance
D. Attenuator Level

The ALC circuit adjusts the audio or microphone input level so Answer **B** is the right choice. The other choices are to distract you.

G8A10 (C)
What is meant by flat-topping of a single-sideband phone transmission?
A. Signal distortion caused by insufficient collector current
B. The transmitter's automatic level control is properly adjusted
C. Signal distortion caused by excessive drive
D. The transmitter's carrier is properly suppressed



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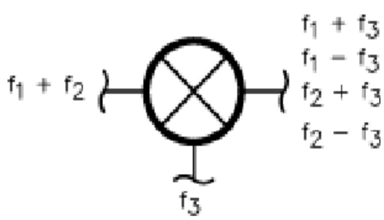
G8A11 (A)
What happens to the RF carrier signal when a modulating audio signal is applied to an FM transmitter?
A. The carrier frequency changes proportionally to the instantaneous amplitude of the modulating signal
B. The carrier frequency changes proportionally to the amplitude and frequency of the modulating signal
C. The carrier amplitude changes proportionally to the instantaneous frequency of the modulating signal
D. The carrier phase changes proportionally to the instantaneous amplitude of the modulating signal

Frequency modulation works with the carrier's frequency. From this, we can eliminate answer D since it concerns the carrier's phase. FM is a constant amplitude modulation so this makes answer C incorrect as well. In FM, the carrier frequency changes in proportion to the input signal's amplitude which makes answer **A** the correct choice. Be careful with answer B, It is close but the FM signal is not proportional to the input signal's frequency so answer B is incorrect.

```
G8A12 (A)
What signal(s) would be found at the output of a properly adjusted balanced
modulator?
A. Both upper and lower sidebands
B. Either upper or lower sideband, but not both
C. Both upper and lower sidebands and the carrier
D. The modulating signal and the unmodulated carrier
```

A balanced mixer gives the upper and lower side bands as the output when properly adjusted which makes answer **A** the correct choice. Answer B is a description of SSB modulation but not the output of a balanced mixer so this is incorrect. Answer C is close but read it carefully and you will see that it includes the carrier signal which is incorrect so this is not the right choice. Answer D is a silly distraction.

```
G8B01 (A)
What receiver stage combines a 14.250 MHz input signal with a 13.795 MHz
oscillator signal to produce a 455 kHz intermediate frequency (IF) signal?
A. Mixer
B. BFO
C. VFO
D. Multiplier
```



The mixer is a device used to shift a signal from one place in the frequency spectrum to another. This process happens by taking the sum and the difference of the frequencies of the input signals. This is what is happening in this question where the 14.25-MHz input is shifted to the 455-kHz output so the correct choice is the mixer as in answer **A**. The multiplier of answer D sounds close but it is not what the component is called. The BFO of answer B would come after this stage so it is eliminated. The VFO generates the 13.795-MHz signal in the question so it is not the correct choice here.

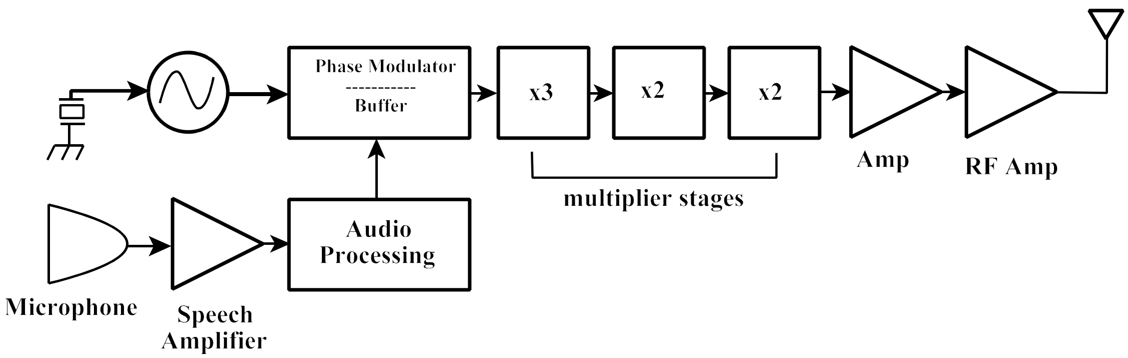
```
G8B02 (B)
If a receiver mixes a 13.800 MHz VFO with a 14.255 MHz received signal to
produce a 455 kHz intermediate frequency (IF) signal, what type of
interference will a 13.345 MHz signal produce in the receiver?
A. Local oscillator
B. Image response
C. Mixer interference
D. Intermediate interference
```

If you subtract 13.8 MHz from 14.255 MHz you obtain 455 kHz. This represents an image frequency so the best choice is **B**. A local oscillator is a signal processing component in your rig so it is eliminated. Answers C and D are not the proper names for this type of signal so they are eliminated as well.

```
G8B03 (A)
What stage in a transmitter would change a 5.3 MHz input signal to 14.3 MHz?
A. A mixer
B. A beat frequency oscillator
C. A frequency multiplier
D. A linear translator
```

Again, we are moving the location of a signals in the frequency domain and the mixer of answer **A** is the right choice. Answer C may sound reasonable but you need to remember that this stage is called the mixer and not the multiplier. The BFO is found in the receiver so answer B is eliminated. Answer D is not part of a transmitter so it is eliminated as well.

```
G8B04 (D)
What is the name of the stage in a VHF FM transmitter that selects a harmonic
of an HF signal to reach the desired operating frequency?
A. Mixer
B. Reactance modulator
C. Pre-emphasis network
D. Multiplier
```



Answer C is incorrect because it operates on the audio input so it is eliminated. The reactance modulator is generating the signal being discussed in this question so answer B is out too. The two answers that are close are A and D. Since we are not just shifting the frequency, the mixer of answer A is not the right choice. You need to remember that this stage in the transmitter is called the multiplier as in answer **D**.

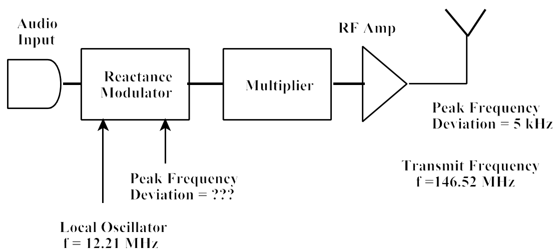
```
G8B05 (C)
Why isn't frequency modulated (FM) phone used below 29.5 MHz?
A. The transmitter efficiency for this mode is low
B. Harmonics could not be attenuated to practical levels
C. The bandwidth would exceed FCC limits
D. The frequency stability would not be adequate
```

FM transmissions are considerably wider than SSB, CW, and RTTY so they are not used on HF bands where they would take up too much frequency spectrum. The choice of answer **C** is the right one. Answers A, B, and D are not true statements so they are eliminated from consideration.

```
G8B06 (D)
What is the total bandwidth of an FM-phone transmission having a 5 kHz
deviation and a 3 kHz modulating frequency?
A. 3 kHz
B. 5 kHz
C. 8 kHz
D. 16 kHz
```

Here we apply Carson's rule to find the answer. The bandwidth is computed using the formula `BW = 2(5000 + 3000) = 16000 Hz` so answer **D** is the right choice. Answer C is wrong because it is missing the factor of 2. Answers A and B are the input values and not the output bandwidth so they are eliminated.

```
G8B07 (B)
What is the frequency deviation for a 12.21-MHz reactance-modulated oscillator
in a 5-kHz deviation, 146.52-MHz FM-phone transmitter?
A. 101.75 Hz
B. 416.7 Hz
C. 5 kHz
D. 60 kHz
```



Here, we need to look at the frequency ratio between the local oscillator driving the reactance modulator and the final transmission frequency to find out the size of the multiplier in the FM transmitter. The multiplier "multiplies up" the oscillator frequency and the frequency deviation from the reactance modulator to the final RF transmission values. Using the values given in the question, we find that the multiplier is `146.52 MHz ÷ 12.21 MHz = 12`. The question is asking us to figure out what the peak deviation of the reactance modulator was if the RF output has a peak frequency deviation of 5 kHz. To find the reactance modulator peak deviation, we need to divide the final 5 kHz by 12 which gives us 416.7 Hz. This corresponds to the answer given in **B**. Answer A looks close but it is off by a factor of 10 so it is wrong. Answers C and D are to see if you understand the process.

```
G8B08 (C)
How is frequency shift related to keying speed in an FSK signal?
A. The frequency shift in hertz must be at least four times the keying speed
      in WPM
B. The frequency shift must not exceed 15 Hz per WPM of keying speed
C. Greater keying speeds require greater frequency shifts
D. Greater keying speeds require smaller frequency shifts
```

This is a general-effects question and generally, greater keying speeds (faster data transmission) require greater frequency shifts to enable the electronics to decode the signal properly and the correct answer is answer **C**. Answer D works just the opposite of the way the transmission process works so it is wrong. Answers A and B are nice and "techie" sounding but they are meaningless to communications engineers and are just here to throw you off.

```
G8B09 (B)
What do RTTY, Morse code, PSK31 and packet communications have in common?
A. They require the same bandwidth
B. They are digital modes
C. They use on/off keying
D. They use phase shift modulation
```

RTTY is a form of digital frequency shift keying. Morse code is also a form of digital communications using on/off keying. PSK31 is a form of digital phase shift keying. Looking at the choices, we can see that the correct one is Answer **B** because they are all digital modes.

G8B10 (B)
When transmitting a data mode signal, why is it important to know the duty cycle of the mode you are using?
A. To aid in tuning your transmitter
B. To prevent damage to your transmitter's final output stage
C. To allow time for the other station to break in during a transmission
D. All of these choices are correct

Many transmitters cannot operate continuously for very long so the duty cycle (ratio of time actually transmitting a signal to the total time) is important for thermal control of the transmitter. This makes answer **B** the right choice to answer this question. Answer A is generally not true which also makes answer D incorrect. Answer C is a silly distraction answer.

G8B11 (D)
What part of the 20 meter band is most commonly used for PSK31 operation?
A. At the bottom of the slow-scan TV segment, near 14.230 MHz
B. At the top of the SSB phone segment, near 14.325 MHz
C. In the middle of the CW segment, near 14.100 MHz
D. Below the RTTY segment, near 14.070 MHz

Since PSK31 is a digital mode like RTTY communications, we would expect to find it in the 14.070 – 14.095 kHz region listed in the 20-meter band plan among the various types of digital data communications. By operating practice, PSK31 is at a lower frequency than RTTY, near 14.070 MHz. Therefore, the correct answer is **D**. The others can be eliminated by careful reading because they are concerned with other modulation formats and the other sections of the 20-meter band plan.

G8B12 (A)
What is another term for the mixing of two RF signals?
A. Heterodyning
B. Synthesizing
C. Cancellation
D. Multiplying

Be careful with the choices here. While the circuit diagram usually has a big “X” for the mixer, the correct term is heterodyning as in answer **A** and not multiplying as in answer D. Synthesizing in answer B is building up a waveform so this is incorrect. Cancellation is not used in this context so answer C is incorrect as well.

Subelement G9 - Antennas and Feedlines

G9A01 (A)
Which of the following factors help determine the characteristic impedance of a parallel conductor antenna feedline?
A. The distance between the centers of the conductors and the radius of the conductors
B. The distance between the centers of the conductors and the length of the line
C. The radius of the conductors and the frequency of the signal
D. The frequency of the signal and the length of the line

The impedance is a function of the geometry of the conductors. It is not a function of the length of the conductor or the operating frequency so we can eliminate Answers B, C and D from further consideration. Answer **A** is the right choice.

G9A02 (B)
What is the typical characteristic impedance of coaxial cables used for antenna feedlines at amateur stations?
A. 25 and 30 ohms
B. 50 and 75 ohms
C. 80 and 100 ohms
D. 500 and 750 ohms

You need to remember that co-axial cable typically comes in 50 and 75 ohm impedances so answer **B** is the correct choice. The other answers are not typical impedances for co-axial cable used in amateur rigs. Read the answers carefully because answer D has numbers similar to the correct ones but off by a factor of 10.

G9A03 (D)
What is the characteristic impedance of flat ribbon TV type twin lead?
A. 50 ohms
B. 75 ohms
C. 100 ohms
D. 300 ohms

You need to remember that twin-lead has an impedance of 300 ohms so answer **D** is the correct choice. Answers A and B are common for co-axial cable so they will look familiar but read the question carefully to make sure you are dealing with twin-lead cable. Answer C is to distract you.

G9A04 (C)
What is a common reason for the occurrence of reflected power at the point where a feedline connects to an antenna?
A. Operating an antenna at its resonant frequency
B. Using more transmitter power than the antenna can handle
C. A difference between feedline impedance and antenna feed point impedance
D. Feeding the antenna with unbalanced feedline

This is another way as asking the impedance matching question again. As such, we should be able to spot the correct answer as choice **C**. Answer A is where you should be operating so it is a wrong choice here. Answers B and D do not cause reflected power by themselves so they are nor good choices either.

G9A05 (D)
What must be done to prevent standing waves on an antenna feedline?
A. The antenna feed point must be at DC ground potential
B. The feedline must be cut to an odd number of electrical quarter wavelengths long
C. The feedline must be cut to an even number of physical half wavelengths long
D. The antenna feed point impedance must be matched to the characteristic impedance of the feedline

The statements in answers A, B, and C will do nothing to prevent standing waves. We know that impedance matching does so answer **D** is the correct choice.

G9A06 (C)
Which of the following is a reason for using an inductively coupled matching network between the transmitter and parallel conductor feed line feeding an antenna?
A. To increase the radiation resistance
B. To reduce spurious emissions
C. To match the unbalanced transmitter output to the balanced parallel conductor feedline
D. To reduce the feed-point impedance of the antenna

The matching network will not change the radiation resistance of the antenna. The matching network is usually a wide-band device so it will not suppress spurious emissions. It will not reduce the feed-point impedance. The matching network is to match the impedances between the transmitter and the feed line so Answer **C** is the correct choice.

G9A07 (B)
How does the attenuation of coaxial cable change as the frequency of the signal it is carrying increases?
A. It is independent of frequency
B. It increases
C. It decreases
D. It reaches a maximum at approximately 18 MHz

The attenuation increases with frequency so Answer **B** is the right choice.

G9A08 (D)
In what values are RF feed line losses usually expressed?
A. ohms per 1000 ft
B. dB per 1000 ft
C. ohms per 100 ft
D. dB per 100 ft

If you purchase co-axial cable you will see that the manufacturers rate it in loss of dB per 100 feet so answer **D** is the best choice. Signal loss is usually measured in deciBels (dB) and not ohms. Typical antenna cable lengths are on the order of 100 feet so this unit should be easy to remember. The other answers are not correct measures of the loss as used to rate co-axial cable under normal circumstances.

G9A09 (A)
What standing-wave-ratio will result from the connection of a 50-ohm feed line to a non-reactive load having a 200-ohm impedance?
A. 4:1
B. 1:4
C. 2:1
D. 1:2

The ratio of the impedances is 200 ÷ 50 or 4:1 so the correct choice is answer **A**. Answer B has the correct numbers but in the wrong order so that answer is out. The other answers are eliminated since they represent math errors.

G9A10 (D)
What standing-wave-ratio will result from the connection of a 50-ohm feed line to a non-reactive load having a 10-ohm impedance?
A. 2:1
B. 50:1
C. 1:5
D. 5:1

The ratio of the impedances is 50 ÷ 10 or 5:1 so the correct choice is answer **D**. Answer C has the correct numbers but in the wrong order so that answer is out. The other answers are eliminated.

G9A11 (B)
What standing-wave-ratio will result from the connection of a 50-ohm feed line to a non-reactive load having a 50-ohm impedance?
A. 2:1
B. 1:1
C. 50:50
D. 0:0

Here, the impedances are the same so the SWR is 1:1 and the correct choice is Answer **B**. Be careful of Answer C because it just uses the impedance values where as the SWR is a ratio. The other answers are to distract you. Answer D is impossible.

G9A12 (A)
What would be the SWR if you feed a vertical antenna that has a 25-ohm feed-point impedance with 50-ohm coaxial cable?
A. 2:1
B. 2.5:1
C. 1.25:1
D. You cannot determine SWR from impedance values

he SWR in this case is easy to compute by taking the resistance ratios. The ratio of 50 Ω to 25 Ω is 2:1 so answer **A** is the correct choice. Answers B and C represent math mistakes. Since we are able to make this computation, then answer D is incorrect.

G9A13 (C)
What would be the SWR if you feed a folded dipole antenna that has a 300-ohm feed-point impedance with 50-ohm coaxial cable?
A. 1.5:1
B. 3:1
C. 6:1
D. You cannot determine SWR from impedance values

The resistance ratio of 300 Ω to 50 Ω is 6 to 1. This makes answer **C** the correct choice. Answer D is incorrect as answer C shows so this choice is eliminated. Answers A and B represent math mistakes.

G9A14 (B)
If the SWR on an antenna feedline is 5 to 1, and a matching network at the transmitter end of the feedline is adjusted to 1 to 1 SWR, what is the resulting SWR on the feedline?
A. 1 to 1
B. 5 to 1
C. Between 1 to 1 and 5 to 1 depending on the characteristic impedance of the line
D. Between 1 to 1 and 5 to 1 depending on the reflected power at the transmitter

If the feedline is 1:1 at the one end and 5:1 on the other, then the resulting SWR on the feedline will be 5:1 as in Answer **B**.

G9B01 (B)
What is one disadvantage of a directly fed random-wire antenna?
A. It must be longer than 1 wavelength
B. You may experience RF burns when touching metal objects in your station
C. It produces only vertically polarized radiation
D. It is not effective on the higher HF bands

None of the statements given in answers A, C, and D would not necessarily be considered disadvantages for all users. Answer **B** is a definite disadvantage so it is the best choice for this question.

G9B02 (D)
What is an advantage of downward sloping radials on a ground-plane antenna?
A. They lower the radiation angle
B. They bring the feed-point impedance closer to 300 ohms
C. They increase the radiation angle
D. They can be adjusted to bring the feed-point impedance closer to 50 ohms

The statements given in answers A, B, and C are each untrue therefore those answers are wrong. Answer **D** is true and is the best choice for this question.

G9B03 (B)
What happens to the feed-point impedance of a ground-plane antenna when its radials are changed from horizontal to downward-sloping?
A. It decreases
B. It increases
C. It stays the same
D. It reaches a maximum at an angle of 45 degrees

You need to remember that this change will generally increase the impedance so answer **B** is the correct choice. The other answers are wrong and are eliminated.

G9B04 (A)
What is the low angle azimuthal radiation pattern of an ideal half-wavelength dipole antenna installed 1/2 wavelength high and parallel to the earth?
A. It is a figure-eight at right angles to the antenna
B. It is a figure-eight off both ends of the antenna
C. It is a circle (equal radiation in all directions)
D. It has a pair of lobes on one side of the antenna and a single lobe on the other side

Dipoles have figure-eight patterns so we can eliminate answers C and D. The figure eights are at right angles to the antenna so the correct answer is **A**. Answer B is wrong because it has the figure 8 coming off at the wrong angle so read the choices carefully.

G9B05 (C)
How does antenna height affect the horizontal (azimuthal) radiation pattern of a horizontal dipole HF antenna?
A. If the antenna is too high, the pattern becomes unpredictable
B. Antenna height has no effect on the pattern
C. If the antenna is less than 1/2 wavelength high, the azimuthal pattern is almost omnidirectional
D. If the antenna is less than 1/2 wavelength high, radiation off the ends of the wire is eliminated

The height does affect the pattern so answer B is eliminated. Answers A and D are not true statements so they are out too. Answer **C** is the best choice for this question.

G9B06 (C)
Where should the radial wires of a ground-mounted vertical antenna system be placed?
A. As high as possible above the ground
B. Parallel to the antenna element
C. On the surface or buried a few inches below the ground
D. At the top of the antenna

These are often called ground radials so answer **C** gives the correct statement about how they are used. Answers A, B, and D will not have the desired effect on the operation of the antenna.

G9B07 (B)
How does the feed-point impedance of a 1/2 wave dipole antenna change as the antenna is lowered from 1/4 wave above ground?
A. It steadily increases
B. It steadily decreases
C. It peaks at about 1/8 wavelength above ground
D. It is unaffected by the height above ground

The impedance changes so Answer D is incorrect. You need to remember that the impedance decreases in this case as given in Answer **B**.

G9B08 (A)
How does the feed-point impedance of a 1/2 wave dipole change as the feed-point location is moved from the center toward the ends?
A. It steadily increases
B. It steadily decreases
C. It peaks at about 1/8 wavelength from the end
D. It is unaffected by the location of the feed-point

Based on the previous question, you may suspect that Answer D is incorrect and it is. You need to remember that it increases in this case so Answer **A** is correct. Answer B was for the previous configuration.

G9B09 (A)
Which of the following is an advantage of a horizontally polarized as compared to vertically polarized HF antenna?
A. Lower ground reflection losses
B. Lower feed-point impedance
C. Shorter Radials
D. Lower radiation resistance

Answers B, C, and D are not necessarily disadvantages without knowing more specifics about the station. However, lower ground reflection losses are something everyone can use and Answer **A** is the best choice to answer the question.

G9B10 (D)
What is the approximate length for a 1/2-wave dipole antenna cut for 14.250 MHz?
A. 8.2 feet
B. 16.4 feet
C. 24.6 feet
D. 32.8 feet

The design equation for a the length of a 1/2-wave dipole is Length (ft) = 468/f(MHz) = 468/14.25 = 32.8 ft. This makes Answer **D** the correct computation. Answer C is for a 1/4-wavelength dipole.

G9B11 (C)
What is the approximate length for a 1/2-wave dipole antenna cut for 3.550 MHz?
A. 42.2 feet
B. 84.5 feet
C. 131.8 feet
D. 263.6 feet

Here we use the same design equation as the previous question: Length = 468/3.55 = 131.8 ft. This computation matches Answer **C**.

G9B12 (A)
What is the approximate length for a 1/4-wave vertical antenna cut for 28.5 MHz?
A. 8.2 feet
B. 10.5 feet
C. 16.4 feet
D. 21.0 feet

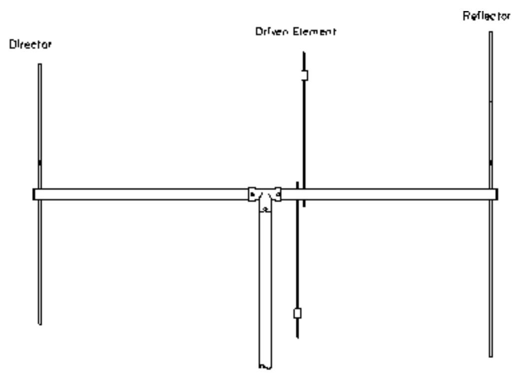
Here we modify the design equation by cutting the 468 factor to 234 to account for going from ½ to 1/4 wavelength.

The computation is Length = 234/28.5 = 8.2 ft. This matches Answer **A**. Be careful, Answer C matches the 1/2-wave case.

```
G9C01 (A)
How can the SWR bandwidth of a Yagi antenna be increased?
A. Use larger diameter elements
B. Use closer element spacing
C. Use traps on the elements
D. Use tapered-diameter elements
```

Of the choices given, the bandwidth is controlled by the element diameter so the correct choice is answer **A**. Generally traps are used to give the antenna overall bands but not used to set the bandwidth within the bands so answer C may sound like something you have heard of before but it is not the best choice. Answers B and D will not have the desired effect of changing the resonant frequency of the antenna.

```
G9C02 (B)
What is the approximate length of the driven element of a Yagi antenna?
A. 1/4 wavelength
B. 1/2 wavelength
C. 3/4 wavelength
D. 1 wavelength
```



You need to remember that the driven segment of a Yagi antenna is approximately ½ wavelength. This makes Answer **B** the correct choice.

```
G9C03 (B)
Which statement about a three-element single-band Yagi antenna is true?
A. The reflector is normally the shortest parasitic element
B. The director is normally the shortest parasitic element
C. The driven element is the longest parasitic element
D. Low feed-point impedance increases bandwidth
```

Answers A, C, and D are all untrue statements. The reflector is the longest parasitic element while the director is the shortest parasitic element. The driven element is not parasitic and its length is mid-way between the reflector's length and the director's length. Answer B is a true statement, therefore answer **B** is the correct choice for this question.

```
G9C04 (A)
Which statement about a Yagi antenna is true?
A. The reflector is normally the longest parasitic element
B. The director is normally the longest parasitic element
C. The reflector is normally the shortest parasitic element
D. All of the elements must be the same length
```

As we can see in the earlier graphic, the reflector is usually the longest parasitic element so Answer **A** is the right choice. The director is normally the shortest. Answer D is incorrect because the elements are of different lengths.

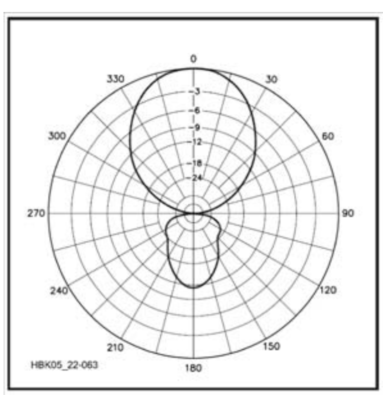
```
G9C05 (A)
What is one effect of increasing the boom length and adding directors to a
Yagi antenna?
A. Gain increases
B. SWR increases
C. Weight decreases
D. Wind load decreases
```

If done correctly, this modification will increase the gain of the antenna so answer **A** is the right choice. Increasing the SWR is usually to be avoided and if the antenna modification is done correctly, the SWR will not increase so answer B is out. Both C and D are untrue statements because these quantities will increase with more antenna elements added.

```
G9C06 (C)
Which of the following is a reason why a Yagi antenna is often used for radio
communications on the 20 meter band?
A. It provides excellent omnidirectional coverage in the horizontal plane
B. It is smaller, less expensive and easier to erect than a dipole or vertical
      antenna
C. It helps reduce interference from other stations to the side or behind the
      antenna
D. It provides the highest possible angle of radiation for the HF bands
```

Because the Yagi antenna has gain and a lobe radiation pattern, answer A is wrong because it refers to an omnidirectional pattern. Yagi antennas are typically more expensive than dipole or vertical antennas so answer B is also out. Answer D is just the opposite of what is desired so it is eliminated as well. The correct choice is answer **C**. Notice here that the band specification is irrelevant to the general operation of the antenna.

```
G9C07 (C)
What does "front-to-back ratio" mean in reference to a Yagi antenna?
A. The number of directors versus the number of reflectors
B. The relative position of the driven element with respect to the reflectors
      and directors
C. The power radiated in the major radiation lobe compared to the power
      radiated in exactly the opposite direction
D. The ratio of forward gain to dipole gain
```



The front-to-back ratio has to do with antenna radiation patterns for any antenna type so the answers in A and B can be eliminated since those answers deal with construction details and not radiation pattern shapes Front and back are the radiation directions and, as you may suspect, they are in opposite directions so the correct choice is **C**. Answer D corresponds to the front-to-side ratio which is not the ratio the question asks for. Notice that in the question, the statement that it is a Yagi antenna is irrelevant.

Source: *2005 ARRL Handbook*, Ver. 9. CD, Chap. 22.

G9C08 (D)
What is meant by the "main lobe" of a directive antenna?
A. The magnitude of the maximum vertical angle of radiation
B. The point of maximum current in a radiating antenna element
C. The maximum voltage standing wave point on a radiating element
D. The direction of maximum radiated field strength from the antenna

Main lobe for any antenna is a field strength direction indication so the correct choice is answer **D**. Answers A, B and C are measurements that could be made but do not tell you what the main lobe is shaped like so they are eliminated. Again, being a Yagi antenna is irrelevant to the question.

G9C09 (A)
What is the approximate maximum theoretical forward gain of a 3 Element Yagi antenna?
A. 9.7 dBi
B. 7.3 dBd
C. 5.4 times the gain of a dipole
D. All of these choices are correct

This is one of those "rule of thumb" values that you will become familiar with. For a 3-element Yagi, a maximum gain of 9.7 is the theoretical maximum so Answer **A** is the right choice.

G9C10 (D)
Which of the following is a Yagi antenna design variable that could be adjusted to optimize forward gain, front-to-back ratio, or SWR bandwidth?
A. The physical length of the boom
B. The number of elements on the boom
C. The spacing of each element along the boom
D. All of these choices are correct

Each of the items in answers A, B, and C is an element in the design of the Yagi antenna so the best choice is Answer **D**.

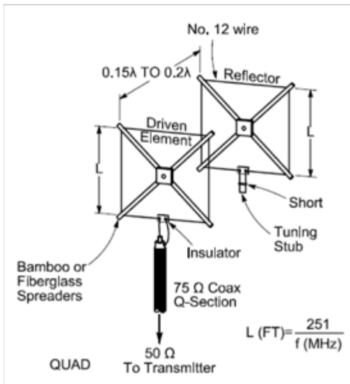
G9C11 (A)
What is the purpose of a "gamma match" used with Yagi antennas?
A. To match the relatively low feed-point impedance to 50 ohms
B. To match the relatively high feed-point impedance to 50 ohms
C. To increase the front to back ratio
D. To increase the main lobe gain

Gamma matching networks are for impedance matching so we can eliminate Answers C and D can be eliminated from consideration. You need to remember that the correct formulation is given in Answer **A**.

G9C12 (D)
Which of the following describes a common method for insulating the driven element of a Yagi antenna from the metal boom when using a gamma match?
A. Support the driven element with ceramic standoff insulators
B. Insert a high impedance transformer at the driven element
C. Insert a high voltage balun at the driven element
D. None of these answers are correct. No insulation is needed

Answer **D** says it all.

G9C13 (A)
Approximately how long is each side of a cubical-quad antenna driven element?
A. 1/4 wavelength
B. 1/2 wavelength
C. 3/4 wavelength
D. 1 wavelength



For a cubical-quad antenna, the driven element is approximately 1/4 wavelength long. This makes Answer **A** the correct choice. Answer B is for a Yagi.

Source: *2005 ARRL Handbook*, Ver. 9. CD, Chap. 22.

G9C14 (B)
How does the forward gain of a 2-element cubical-quad antenna compare to the forward gain of a 3 element Yagi antenna?
A. 2/3
B. About the same
C. 3/2
D. Twice

Again, this is another “rule of thumb” relationship. You need to remember that they are about the same so Answer **B** is correct.

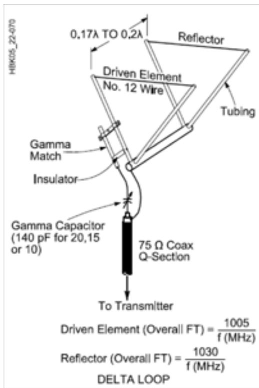
G9C15 (B)
Approximately how long is each side of a cubical-quad antenna reflector element?
A. Slightly less than 1/4 wavelength
B. Slightly more than 1/4 wavelength
C. Slightly less than 1/2 wavelength
D. Slightly more than 1/2 wavelength

The design equation for the reflector element is that it is slightly longer than 1/4 wavelength so Answer **B** is the right choice.

G9C16 (D)
How does the gain of a two element delta-loop beam compare to the gain of a two element cubical quad antenna?
A. 3 dB higher
B. 3 dB lower
C. 2.54 dB higher
D. About the same

Here is another “about the same” relationship to remember. Be sure to chose Answer **D**.

G9C17 (B)
Approximately how long is each leg of a symmetrical delta-loop antenna Driven element?
A. 1/4 wavelengths
B. 1/3 wavelengths
C. 1/2 wavelengths
D. 2/3 wavelengths



For a delta-loop, the driven element legs are about 1/3 wavelength long so Answer **B** is the correct choice. Remember that 1/4 was for the cubical quad and ½ was for the Yagi.

Source: *2005 ARRL Handbook*, Ver. 9. CD, Chap. 22.

G9C18 (D)
Which of the following antenna types consists of a driven element and some combination of parasitically excited reflector and/or director elements?
A. A collinear array
B. A rhombic antenna
C. A double-extended Zepp antenna
D. A Yagi antenna

The is the text description of a Yagi antenna so Answer **D** is the correct choice.

G9C19 (C)
What type of directional antenna is typically constructed from 2 square loops of wire each having a circumference of approximately one wavelength at the operating frequency and separated by approximately 0.2 wavelength?
A. A stacked dipole array
B. A collinear array
C. A cubical quad antenna
D. An Adcock array

The is a text description for a cubical quad antenna so Answer **C** is the right choice.

G9C20 (A)
What happens when the feed-point of a cubical quad antenna is changed from the center of the lowest horizontal wire to the center of one of the vertical wires?
A. The polarization of the radiated signal changes from horizontal to vertical
B. The polarization of the radiated signal changes from vertical to horizontal
C. The direction of the main lobe is reversed
D. The radiated signal changes to an omnidirectional pattern

You need to remember that the polarization changes from horizontal to vertical and be sure to choose Answer **A**.

G9C21 (D)
What configuration of the loops of a cubical-quad antenna must be used for the antenna to operate as a beam antenna, assuming one of the elements is used as a reflector?
A. The driven element must be fed with a balun transformer
B. The driven element must be open-circuited on the side opposite the feed-point
C. The reflector element must be approximately 5% shorter than the driven element
D. The reflector element must be approximately 5% longer than the driven element

Since the reflector is longer than the driven element, then Answer **D** is the right choice.

G9D01 (D)
What does the term "NVIS" mean as related to antennas?
A. Nearly Vertical Inductance System
B. Non-Visible Installation Specification
C. Non-Varying Impedance Smoothing
D. Near Vertical Incidence Skywave

The correct reading of NVIS is given in Answer **D**. The other choices are to distract you when reading the question.

G9D02 (B)
Which of the following is an advantage of an NVIS antenna?
A. Low vertical angle radiation for DX work
B. High vertical angle radiation for short skip during the day
C. High forward gain
D. All of these choices are correct

NVIS uses a high vertical angle and is for daytime skip so Answer **B** is the right choice.

G9D03 (D)
At what height above ground is an NVIS antenna typically installed?
A. As close to one-half wave as possible
B. As close to one wavelength as possible
C. Height is not critical as long as significantly more than 1/2 wavelength
D. Between 1/10 and 1/4 wavelength

The NVIS antenna is typically installed close to the ground – between 1/10 and 1/4 wavelength so Answer **D** is the correct choice. This is done to force most of the RF signal sky-ward.

G9D04 (B)
How does the gain of two 3-element horizontally polarized Yagi antennas spaced vertically 1/2 wave apart from each other typically compare to the gain of a single 3-element Yagi?
A. Approximately 1.5 dB higher
B. Approximately 3 dB higher
C. Approximately 6 dB higher
D. Approximately 9 dB higher

Two antennas will give you gain – the question is just how much. In this case, you will get about another 3 dB so Answer **B** is the right choice.

G9D05 (D)
What is the advantage of vertical stacking of horizontally polarized Yagi antennas?
A. Allows quick selection of vertical or horizontal polarization
B. Allows simultaneous vertical and horizontal polarization
C. Narrows the main lobe in azimuth
D. Narrows the main lobe in elevation

In this case, the main lobe elevation is narrowed so Answer **D** is the right choice.

G9D06 (A)
Which of the following is an advantage of a log periodic antenna?
A. Wide bandwidth
B. Higher gain per element than a Yagi antenna
C. Harmonic suppression
D. Polarization diversity

Log periodic antennas are known for having a wide bandwidth so Answer **A** is the one to choose.

G9D07 (A)
Which of the following describes a log periodic antenna?
A. Length and spacing of the elements increases logarithmically from one end of the boom to the other
B. Impedance varies periodically as a function of frequency
C. Gain varies logarithmically as a function of frequency
D. SWR varies periodically as a function of boom length

By looking at the graphic, we can see that the antenna elements are not evenly spaced and the length of each element gradually increases. This matches the description of Answer **A**.

G9D08 (B)
Why is a Beverage antenna generally not used for transmitting?
A. Its impedance is too low for effective matching
B. It has high losses compared to other types of antennas
C. It has poor directivity
D. All of these choices are correct

Beverage antennas are highly directive so Answer C is incorrect. If Answer C is incorrect, then Answer D is also incorrect. While it has low radiation resistance, that does not mean that it cannot be matched. The correct reason is in Answer **B** because typical gains are -20 to -10 dB implying a large loss in the antenna.

G9D09 (B)
Which of the following is an application for a Beverage antenna?
A. Directional transmitting for low HF bands
B. Directional receiving for low HF bands
C. Portable Direction finding at higher HF frequencies
D. Portable Direction finding at lower HF frequencies

Beverage antennas are mostly used for receiving so Answer **B** is correct. Because they are very large antennas, they are not good for direction finding activities because they typically are not moved once installed.

G9D10 (D)
Which of the following describes a Beverage antenna?
A. A vertical antenna constructed from beverage cans
B. A broad-band mobile antenna
C. A helical antenna for space reception
D. A very long and low receiving antenna that is highly directional

The correct text description of a Beverage antenna is given in Answer **D**. Answer A is a silly distraction answer.

G9D11 (D)
Which of the following is a disadvantage of multiband antennas?
A. They present low impedance on all design frequencies
B. They must be used with an antenna tuner
C. They must be fed with open wire line
D. They have poor harmonic rejection

Because multi-band antennas need to transmit across many amateur bands and the amateur bands have harmonic relationships, this type of antenna cannot be designed for harmonic suppression without compromising performance. This makes Answer **D** the right choice.

G9D12 (A)
What is the primary purpose of traps installed in antennas?
A. To permit multiband operation
B. To notch spurious frequencies
C. To provide balanced feed-point impedance
D. To prevent out of band operation

Traps are inductors that allow the antenna to be tuned across multiple bands. This permits multiband operation as in Answer **A**.

Subelement G0 - Electrical and RF Safety

G0A01 (A)
What is one way that RF energy can affect human body tissue?
A. It heats body tissue
B. It causes radiation poisoning
C. It causes the blood count to reach a dangerously low level
D. It cools body tissue

As you may suspect, answer D is not true. Answer B is generally most concerned with effects caused by energetic particles and high-energy electromagnetic radiation and not the lower-energy RF radiation found in amateur radio so is not the best choice. Answer C is also not true for the RF radiation used in amateur rigs. The best choice among the options given is answer **A**.

G0A02 (B)
Which property is NOT important in estimating if an RF signal exceeds the maximum permissible exposure (MPE)?
A. Its duty cycle
B. Its critical angle
C. Its power density
D. Its frequency

The properties in answers A, C, and D are all important so they are not the right answer to this question since we are searching for a wrong answer. The critical angle of answer **B** has to do with the RF radiation exiting the atmosphere so it is a wrong property for making the estimate of radiation damage to the body and it is the right answer to this question.

G0A03 (B)
Which of the following has the most direct effect on the permitted exposure level of RF radiation?
A. The age of the person exposed
B. The power level and frequency of the energy
C. The environment near the transmitter
D. The type of transmission line used

The permitted exposure levels are broken down by frequency because that is the most sensitive parameter which makes answer **B** the right choice. Answer A will not be much of a factor because human tissue reacts basically the same at any age. Answers C is true but it is not as good a choice as answer B.

G0A04 (D)
What does "time averaging" mean in reference to RF radiation exposure?
A. The average time of day when the exposure occurs
B. The average time it takes RF radiation to have any long-term effect on the body
C. The total time of the exposure
D. The total RF exposure averaged over a certain time

Answer A is intended to give you a bit of a grin and it is eliminated. Answers B, C, and D may all look reasonable on the surface but only answer **D** contains the correct definition for time averaging. The other two are to distract you.

G0A05 (A)
What must you do if an evaluation of your station shows RF energy radiated from your station exceeds permissible limits?
A. Take action to prevent human exposure to the excessive RF fields
B. File an Environmental Impact Statement (EIS-97) with the FCC
C. Secure written permission from your neighbors to operate above the controlled MPE limits
D. All of these answers are correct

Answer B is incorrect since the EIS is not required in this case. Answer C is not correct – the government will not allow the neighbors to overrule the standard. Answer D is also incorrect because action is required when the limits are exceeded. Answer **A** provides the best response for this question – you must take action to correct the situation.

G0A06 (C)
Which transmitter(s) at a multiple user site is/are responsible for RF safety compliance?
A. Only the most powerful transmitter on site
B. All transmitters on site, regardless of their power level or duty cycle
C. Any transmitter that contributes 5% or more of the MPE
D. Only those that operate at more than 50% duty cycle

While we learned in the Technician Class that by good engineering practice, all transmitters should be involved in site evaluation. However, this question and a following question address the minimal legal requirements for site evaluation under OET Bulletin 65. The formulation for the *minimum* requirements for the multiple station evaluation are given in Answer **C** so this is the best choice to answer this question. Answers A, B and D do not conform to the rules so they are incorrect.

G0A07 (A)
What effect does transmitter duty cycle have when evaluating RF exposure?
A. A lower transmitter duty cycle permits greater short-term exposure levels
B. A higher transmitter duty cycle permits greater short-term exposure levels
C. Low duty cycle transmitters are exempt from RF exposure evaluation requirements
D. Only those transmitters that operate at a 100% duty cycle must be evaluated

Answers C and D are untrue statements according to the rules and are eliminated. Answer B is just the opposite of the true statement so it is out too. Answer **A** is the correct choice for this question.

G0A08 (C)
Which of the following steps must an amateur operator take to ensure compliance with RF safety regulations?
A. Post a copy of FCC Part 97 in the station
B. Post a copy of OET Bulletin 65 in the station
C. Perform a routine RF exposure evaluation
D. All of these choices are correct

Merely posting a copy of the rules does not ensure compliance so answers A and B are not correct. This makes Answer D incorrect. Only answer **C** might be a help so it is the best choice for this question.

G0A09 (B)
What type of instrument can be used to accurately measure an RF field?
A. A receiver with an S meter
B. A calibrated field-strength meter with a calibrated antenna
C. A betascope with a dummy antenna calibrated at 50 ohms
D. An oscilloscope with a high-stability crystal marker generator

An S meter is a crude relative measurement so answer A is out. A betascope detects beta particles (electrons) and will not measure RF energy so answer C is out. Answer D is used in checking the frequency of the carrier and not the field strength so it is not appropriate in this context. The correct way to make the measurement is the one given in answer **B**.

G0A10 (D)
What do the RF safety rules require when the maximum power output capability of an otherwise compliant station is reduced?
A. Filing of the changes with the FCC
B. Recording of the power level changes in the log or station records
C. Performance of a routine RF exposure evaluation
D. No further action is required

If you were in compliance at the higher power, then you will still be in compliance at the lower power so no further action is required. Answer **D** is in compliance with the rules while the other choices are not.

G0A11 (C)
What precaution should you take if you install an indoor transmitting antenna?
A. Locate the antenna close to your operating position to minimize feed line radiation
B. Position the antenna along the edge of a wall to reduce parasitic radiation
C. Make sure that MPE limits are not exceeded in occupied areas
D. No special precautions are necessary if SSB and CW are the only modes used

Because this is an indoor antenna, we must be careful about exposure to the building occupants. Therefore, answer **C** is the best choice for this question. Answers A, B, and D are not concerned with protecting the occupants so they are eliminated.

G0A12 (B)
What precaution should you take whenever you make adjustments or repairs to an antenna?
A. Ensure that you and the antenna structure are grounded
B. Turn off the transmitter and disconnect the feedline
C. Wear a radiation badge
D. All of these answers are correct

Of the choices given, only answer **B** will prevent RF radiation from being emitted so it is the best choice for this question. The others do not contribute to RF safety.

G0A13 (D)
What precaution should be taken when installing a ground-mounted antenna?
A. It should not be installed higher than you can reach
B. It should not be installed in a wet area
C. It should be painted so people or animals do not accidentally run into it
D. It should be installed so no one can be exposed to RF radiation in excess of maximum permissible limits

Since we are dealing with RF safety, only answer **D** will insure that the system is safe. The other answers do not address RF safety.

G0A14 (D)
What is one thing that can be done if evaluation shows that a neighbor might receive more than the allowable limit of RF exposure from the main lobe of a directional antenna?
A. Change from horizontal polarization to vertical polarization
B. Change from horizontal polarization to circular polarization
C. Use an antenna with a higher front-to-back ratio
D. Take precautions to ensure that the antenna cannot be pointed at their house

Changing the polarization will not change the power density radiated towards your neighbors so answers A and B are eliminated. Answer C may actually increase the radiation towards the neighbors so it is out too. Answer **D** is the correct choice for this question.

G0A15 (D) [97.13(c)(1)]
How can you determine that your station complies with FCC RF exposure regulations?
A. By calculation based on FCC OET Bulletin 65
B. By calculation based on computer modeling
C. By measurement of field strength using calibrated equipment
D. All of these choices are correct

The Part 97 rules state that before "causing or allowing an amateur station to transmit from any place where the operation of the station could cause human exposure to RF electromagnetic field levels in excess of those allowed under Sec. 1.1310 of this chapter, the licensee is required to take certain actions." The actions are to perform a station evaluation using the methods given in Answers A, B, and C. This makes Answer **D** the best choice.

G0B01 (A)
Which wire(s) in a four-conductor line cord should be attached to fuses or circuit breakers in a device operated from a 240-VAC single-phase source?
A. Only the "hot" (black and red) wires
B. Only the "neutral" (white) wire
C. Only the ground (bare) wire
D. All wires

The neutral and ground wires in answers B and C should not be fused to ensure proper circuit operation when faults occur so they are wrong answers. Answer D is also wrong because it would include fusing the neutral and ground. The correct choice is answer **A**.

G0B02 (C)
What is the minimum wire size that may be safely used for a circuit that draws up to 20 amperes of continuous current?
A. AWG number 20
B. AWG number 16
C. AWG number 12
D. AWG number 8

You need to remember that the 12-gauge wire in answer **D** is rated for 20 amps. The wire gauges listed in answers A, B, and C are rated at lower currents so they are not the correct answer.

G0B03 (D)
Which size of fuse or circuit breaker would be appropriate to use with a circuit that uses AWG number 14 wiring?
A. 100 amperes
B. 60 amperes
C. 30 amperes
D. 15 amperes

14-gauge wire is rated for 15 amps at most so Answer **D** is the right choice. Using any of those higher current could be a safety hazard.

G0B04 (A)
What is the mechanism by which electrical shock can be lethal?
A. Current through the heart can cause the heart to stop pumping
B. A large voltage field can induce currents in the brain
C. Heating effects in major organs can cause organ failure
D. All of these choices are correct

Electric shocks become lethal when they disrupt the heart. This makes Answer **A** the correct choice.

G0B05 (B)
Which of the following conditions will cause a Ground Fault Circuit Interrupter (GFCI) to disconnect the 120 or 240 Volt AC line power to a device?
A. Current flowing from the hot wire to the neutral wire
B. Current flowing from the hot wire to ground
C. Over-voltage on the hot wire
D. All of these choices are correct

The ground fault interrupter looks for current on the ground wire. This makes Answer **B** the correct choice.

G0B06 (D)
Why must the metal chassis of every item of station equipment be grounded (assuming the item has such a chassis)?
A. It prevents blowing of fuses in case of an internal short circuit
B. It provides a ground reference for the internal circuitry
C. It ensures that the neutral wire is grounded
D. It ensures that hazardous voltages cannot appear on the chassis

If all of the chassis of every item in the shack is tied to the station ground, then hazardous voltages will be directed to the ground and not to the person touching the chassis. This makes Answer **D** the best choice here. Answer b is close because many circuits have their grounds tied to the chassis. However, unless the chassis is tied to ground, you could be shocked.

G0B07 (B)
Which of the following should be observed for safety when climbing on a tower using a safety belt or harness?
A. Never lean back and rely on the belt alone to support your weight
B. Always attach the belt safety hook to the belt "D" ring with the hook opening away from the tower
C. Ensure that all heavy tools are securely fastened to the belt D ring
D. Make sure that your belt is grounded at all times

Answer **B** will keep any accidental brushes against the tower from opening the safety harness so this is the best answer here. Answer A is probably a good idea but not as good as Answer B. Answer C is not a good choice. Answer D will be difficult to accomplish and of little value.

G0B08 (B)
What should be done by any person preparing to climb a tower that supports electrically powered devices?
A. Notify the electric company that a person will be working on the tower
B. Make sure all circuits that supply power to the tower are locked out and tagged
C. Ground the base of the tower
D. Disconnect the feed-line for every antenna at the station

Answer **B** makes sure that all powered devices are disabled so it is the best choice. Answer D is a good idea but it does not help with other powered devices around the tower. Answers A and C will not prevent electrical hazards.

G0B09 (D)
Why is it not safe to use soldered joints with the wires that connect the base of a tower to a system of ground rods?
A. The resistance of solder is too high
B. Solder flux will prevent a low conductivity connection
C. Solder has too high a dielectric constant to provide adequate lightning protection
D. A soldered joint will likely be destroyed by the heat of a lightning strike

All of the reasons given in Answers A, B, and C are electrically untrue. Answer **D** is correct since the lightening could melt the solder.

G0B10 (A)
Which of the following is a danger from lead-tin solder?
A. Lead can contaminate food if hands are not washed carefully after handling
B. High voltages can cause lead-tin solder to disintegrate suddenly
C. Tin in the solder can "cold flow" causing shorts in the circuit
D. RF energy can convert the lead into a poisonous gas

Answers B, C, and D are all untrue. Answer **A** is correct which is one reason that the electronics industry is moving away from lead wherever possible.

G0B11 (D)
Which of the following is good engineering practice for lightning protection grounds?
A. They must be bonded to all buried water and gas lines
B. Bends in ground wires must be made as close as possible to a right angle
C. Lightning grounds must be connected to all ungrounded wiring
D. They must be bonded together with all other grounds

Lightening protection grounds are to be bonded with other grounds so Answer **D** is the right choice. Electrically, each of the other statements is untrue.

G0B12 (C)
What is the purpose of a transmitter power supply interlock?
A. To prevent unauthorized access to a transmitter
B. To guarantee that you cannot accidentally transmit out of band
C. To ensure that dangerous voltages are removed if the cabinet is opened
D. To shut off the transmitter if too much current is drawn

The best reason is given in Answer **C** because that promotes electrical safety. Answer A is a good reason but not as good as Answer C. Answer B is not possible with a simple interlock. Answer D is called a fuse.

G0B13 (B)
Which of the following is the most hazardous type of electrical energy?
A. Direct Current
B. 60 cycle Alternating current
C. Radio Frequency
D. All of these choices are correct

We have RF energy passing through us every day without harm so Answer C is eliminated from consideration. This also means that Answer D is incorrect. Answer **B** is the correct choice. Interestingly, the hazards of 60 Hz current was listed as a reason not to have AC when the country was deciding AC versus DC for the commercial electrical power grid.

G0B14 (B)
What is the maximum amount of electrical current flow through the human body that can be tolerated safely?
A. 5 microamperes
B. 50 microamperes
C. 500 milliamperes
D. 5 amperes

50 mA directly across the heart is enough to disrupt heart rhythms. Anything more than that is to be avoided. This makes Answer **B** the correct choice.

Appendix - Tables and References

Band Usage Summary						
Freq.	**Band**	**Designator**	**General Authorization**	**Data Rate (baud)**	**Voice Side Band**	**GAE Max. Power**
435 MHz	70 cm	UHF	420 – 450 MHz	56 k	Upper	1500 W whole band
223 MHz	1.25 m	VHF	222 – 225 MHz	56 k	Upper	1500 W whole band
144 MHz	2 m	VHF	144 – 148 MHz	19.6 k	Upper	1500 W whole band
50 MHz	6 m	VHF	50.0 – 54.0 MHz	19.6 k	Upper	1500 W whole band
28000 kHz	10 m	HF	28000 – 29700 kHz	1200	Upper	1500 W whole band
24900 kHz	12 m	HF	24800 – 24990 kHz	300	Upper	1500 W whole band
21000 kHz	15 m	HF	21025 – 21200 kHz 21300 – 21450 kHz	300	Upper	21.1 - 21.2 – 200 W elsewhere – 1500 W
18000 kHz	17 m	HF	18068 – 18168 kHz	300	Upper	1500 W whole band
14000 kHz	20 m	HF	14025 – 14150 kHz 14225 – 14350 kHz	300	Upper	1500 W whole band

Band Usage Summary						
Freq.	**Band**	**Designator**	**General Authorization**	**Data Rate (baud)**	**Voice Side Band**	**GAE Max. Power**
10100 kHz	30 m	HF	10100 – 10150 kHz	300	not allowed	200 W whole band
7000 kHz	40 m	HF	7025 – 7150 kHz 7225 – 7300 kHz	300	Lower	7100 - 7150 – 200 W elsewhere – 1500 W
only use one of the channels	60 m	HF	5330.5, 5346.5, 5366.5, 5371.5 5403.5 kHz	not allowed	Upper	50 W PEP relative to a $\lambda/2$ dipole
3900 kHz	75 m	HF	3850 – 4000 kHz	300	Lower	1500 W whole band
3500 kHz	80 m	HF	3525 – 3750 kHz	300	Lower	3675 - 3725 – 200 W elsewhere – 1500 W
1900 kHz	160 m	MF	1800 – 2000 kHz	300	Lower	1500 W whole band

Band Designations	
Band	**Frequency Range**
ultra-low frequency (ULF)	< 3 Hz
extremely low frequency (ELF)	3 Hz - 3 kHz
very low frequency (VLF)	3 - 30 kHz
low frequency (LF)	30 - 300 kHz
medium frequency (MF)	300 kHz - 3 MHz
high frequency (HF)	3 - 30 MHz
very high frequency (VHF)	30 - 300 MHz
ultra high frequency (UHF)	300 MHz - 3 GHz
super high frequency (SHF)	3 - 30 GHz
extremely high frequency (EHF)	30 - 300 GHz

Useful Equations		
Ohm's Law	$E = RI$ $I = E / R$ $R = E / I$	E ~ voltage (Volts) I ~ current (Amperes) R ~ resistance (Ohms, Ω)
Power	$P = EI$ $P = E^2 / R$ $P = I^2 R$	P ~ power (Watts)
Decibels	$dB = 10 \log\left(\frac{P_2}{P_1}\right)$	
RMS Voltage	$V_{RMS} = 0.707 PEV$ $PEP = [PEV^2] \div (2R_L)$	PEV ~ Peak Envelope Voltage PEP ~ Peak Envelope Power R_L ~ Load Resistance

Useful Equations	
Transformer Turns	$\left(\frac{E_S}{E_P}\right)=\left(\frac{N_S}{N_P}\right)$ $\sqrt{\frac{R_P}{R_S}}=\left(\frac{N_S}{N_P}\right)$ Es ~ secondary voltage Ep ~ primary voltage Ns ~ number of secondary turns Np ~ number of primary turns Rs ~ secondary resistance Rp ~ primary resistance
FM Bandwidth (Carson's Rule)	$BW = 2(D+M)$ D ~ maximum deviation M ~ maximum input signal frequency
Wavelength (feet)	$\lambda = \frac{936}{f\,(MHz)}$
Dipole Antenna	1/2-wave: $\lambda / 2 = \frac{468}{f\,(MHz)}$
Yagi Antenna	Driven Element: $\lambda / 2 = \frac{468}{f\,(MHz)}$ Director Element: 95% of the length of the driven element Reflector Element: 105% of the length of the driven element
Cubical Quad Antenna	Driven Element (ft): 1005 / f (in MHz) / 4 Director Element (ft): 975 / f (in MHz) / 4 Reflector Element (ft): 1030 / f (in MHz) / 4
Delta Loop Antenna	Driven Element (ft): 1005 / f (in MHz) / 3 Reflector Element (ft): 1030 / f (in MHz) / 3
Field Strength	$\frac{\text{Field Strength}_2}{\text{Field Strength}_1} = \frac{\text{Distance}_1}{\text{Distance}_2}$
Power Density	$\frac{\text{Power Density}_2}{\text{Power Density}_1} = \frac{(\text{Distance}_1)^2}{(\text{Distance}_2)^2}$

Web Sites	
Beacons	http://www.ncdxf.org
Propagation Bulletins	http://www.arrl.org/w1aw/prop can sign up there for e-mail delivery of bulletins
Solar Activity	http://www.sec.noaa.gov/today.html http://www.spaceweather.com/ http://www.sunspots.com
RF Safety	http://www.fcc.gov/oet/rfsafety/
FCC Amateur Radio Service	http://wireless.fcc.gov/services/amateur/
FCC Part 97	http://wireless.fcc.gov/rules.html

Digital Modes	
Web Site	**Contents**
http://www.aintel.bi.ehu.es/psk31.html	PSK 31 Home Page
http://www.qsl.net/zl1bpu/MFSK/	MFSK16 Home Page
http://users.mesatop.com/~ghansen/	HamScope control software for PSK31, MFSK16, RTTY
http://members.home.net/hteller/digipan/download.htm	DigiPan control software for PSK31
http://www.qsl.net/ae4jy/	WinPSK control software for PSK31
http://iz8bly.sysonline.it/Stream/index.htm	Stream control software for MFSK16
http://www.westmountainradio.com/	RigBlaster PC/rig control interface

Time and Frequency Services	
Station	**Frequencies**
WWV	2.5, 5, 10, 15, 20 MHz
WWVH	2.5, 5, 10, 15 MHz
CHU	3.330, 7.335 MHz, 14.670 MHz

US Amateur Radio Bands

US AMATEUR POWER LIMITS

At all times, transmitter power should be kept down to that necessary to carry out the desired communications. Power is rated in watts PEP output. Except where noted, the maximum power output is ***1500 Watts***.

Effective Date February 23, 2007

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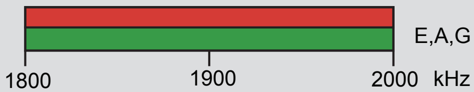
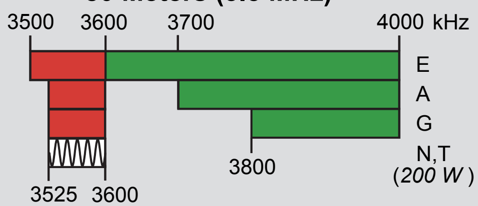
160 Meters (1.8 MHz)

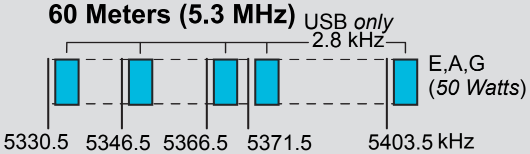
Avoid interference to radiolocation operations from 1900 to 2000 kHz



80 Meters (3.5 MHz)

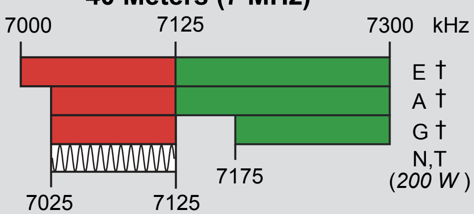


60 Meters (5.3 MHz)



General, Advanced, and Amateur Extra licensees may use the following five channels on a secondary basis with a maximum effective radiated power of 50 W PEP relative to a half wave dipole. Only upper sideband suppressed carrier voice transmissions may be used. The frequencies are 5330.5, 5346.5, 5366.5, 5371.5 and 5403.5 kHz. The occupied bandwidth is limited to 2.8 kHz centered on 5332, 5348, 5368, 5373, and 5405 kHz respectively.

40 Meters (7 MHz)

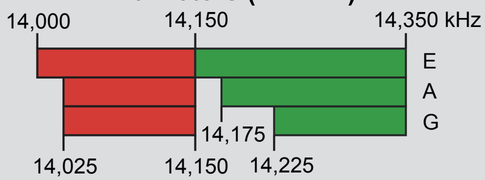


† Phone and Image modes are permitted between 7075 and 7100 kHz for FCC licensed stations in ITU Regions 1 and 3 and by FCC licensed stations in ITU Region 2 West of 130 degrees West longitude or South of 20 degrees North latitude. See Sections 97.305(c) and 97.307(f)(11). Novice and Technician licensees outside ITU Region 2 may use CW only between 7025 and 7075 kHz. See Section 97.301(e). These exemptions do not apply to stations in the continental US.

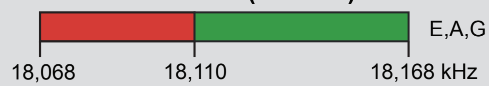
30 Meters (10.1 MHz)

Avoid interference to fixed services outside the US.

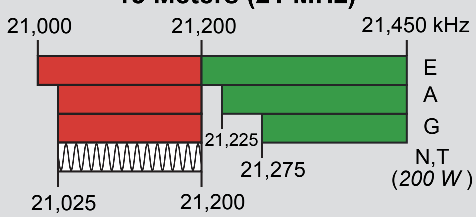
20 Meters (14 MHz)



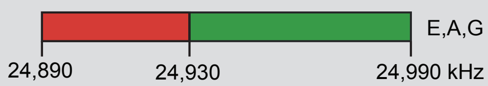
17 Meters (18 MHz)



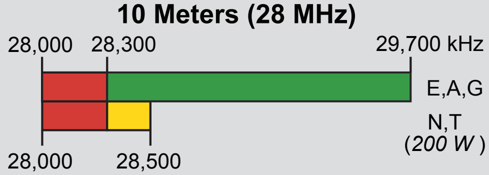
15 Meters (21 MHz)



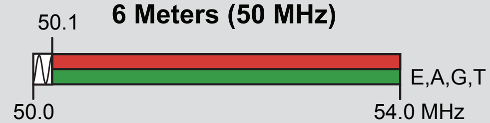
12 Meters (24 MHz)



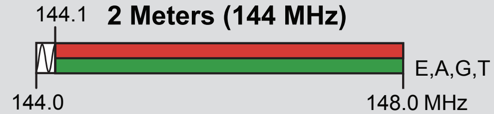
10 Meters (28 MHz)



6 Meters (50 MHz)



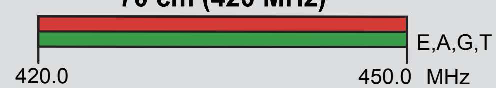
2 Meters (144 MHz)



1.25 Meters (222 MHz)

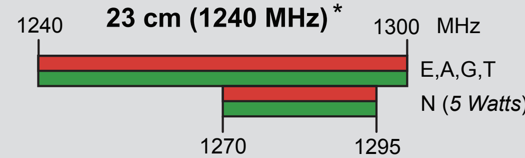
*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

70 cm (420 MHz)*



33 cm (902 MHz)*

23 cm (1240 MHz)*



All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
3300-3500 MHz	47.0-47.2 GHz	241-250 GHz
5650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

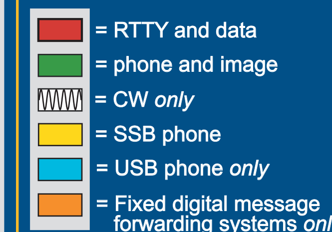
KEY

Note:

CW operation is permitted throughout all amateur bands except 60 meters.

MCW is authorized above 50.1 MHz, except for 219-220 MHz.

Test transmissions are authorized above 51 MHz, except for 219-220 MHz



E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See *ARRLWeb at www.arrl.org* for more detailed band plans.

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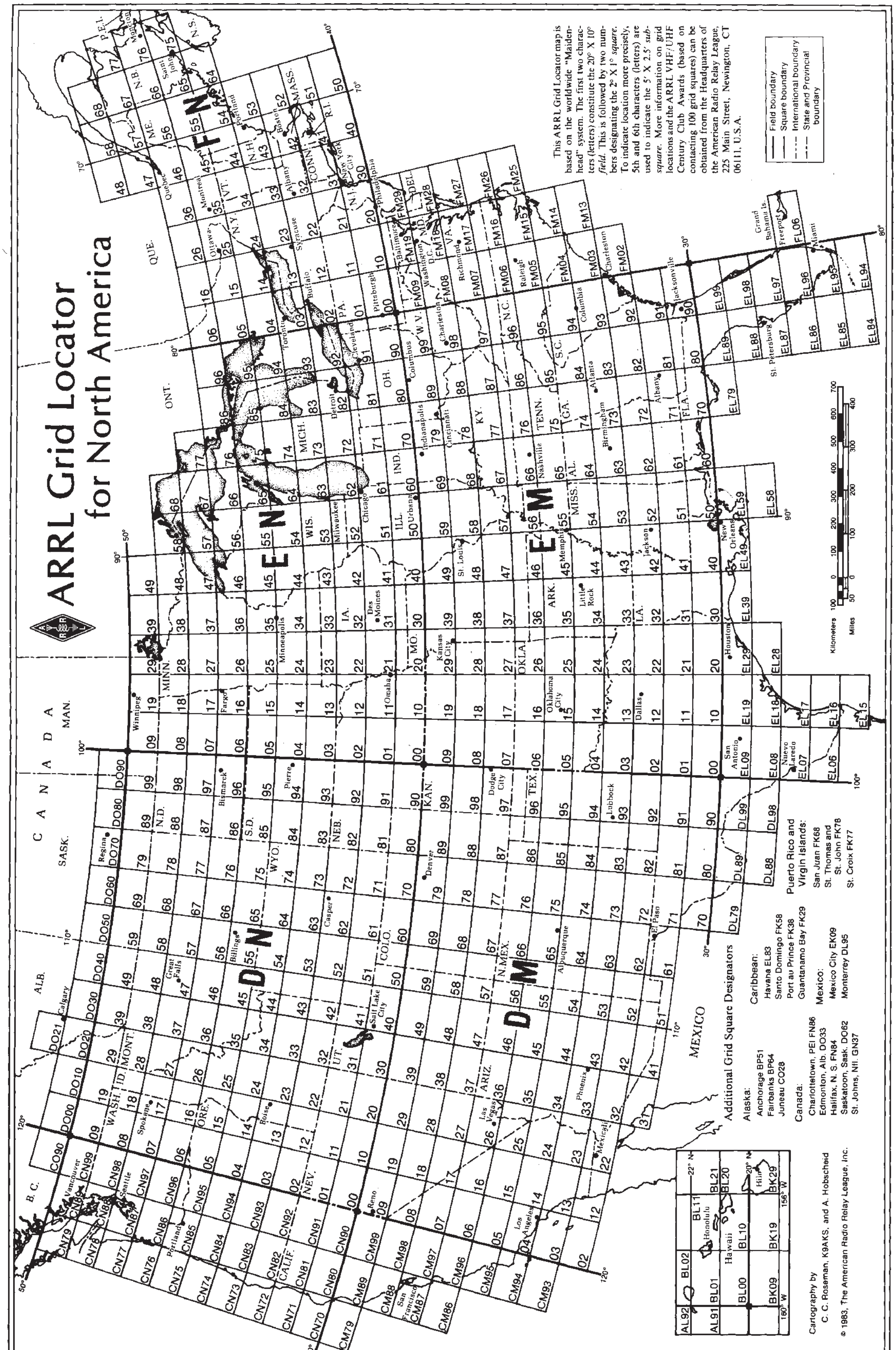
Table 7.82

ARRL Grid Locator Map for North America

This and a World Grid Locator Map are available from ARRL.



Additional Information for Amateurs Completing Form 605

Form 605 Requires the Applicant Sign an RF Safety Certification.

The Form 605 requires that all applicants now sign an RF Safety Certification. The certification that applicants must now sign reads: "I have READ and WILL COMPLY with Section 97.13(c) of the Commission's Rules regarding RADIOFREQUENCY (RF) RADIATION SAFETY and the amateur service section of OST/OET Bulletin Number 65." This is all well and good, but how can you sign this statement if you haven't seen these new rules and Bulletin 65 information? Unfortunately, FCC has not provided this additional information in the instructions to the new Form 605!

Recognizing this need, here is the information you will need to read and must comply with. Section 97.13(c) reads:
c. Before causing or allowing an amateur station to transmit from any place where the operation of the station could cause human exposure to RF electromagnetic field levels in excess of those allowed under §1.1310 of this chapter, the licensee is required to take certain actions.

1. The licensee must perform the routine RF environmental evaluation prescribed by §1.1307(b) of this chapter, if the power of the licensee's station exceeds the limits given in the following table:

Wavelength Band & Evaluation Required if Power (watts) Exceeds*

MF/HF		*12m = 75 watts*		*23cm = 200 watts*
160m - 40m = 500 watts		*10m = 50 watts*		*13cm = 250 watts*
30m = 425 watts		*VHF all bands = 50 watts*		
20m = 225 watts		*UHF*		*SHF all bands = 250 watts*
17m = 125 watts		*70cm = 70 watts*		
15m = 100 watts		*33cm = 150 watts*		*EHF all bands = 250 watts*

- Repeater stations (all bands) non-building-mounted antennas:
height above ground level to lowest point of antenna < 10 m and power > 500 W ERP
- Building-mounted antennas: power > 500 W ERP

** Power = PEP input to antenna except, for repeater stations only, power exclusion is based on ERP (effective radiated power).*

2. If the routine environmental evaluation indicates that the RF electromagnetic fields could exceed the limits contained in §1.1310 of this chapter in accessible areas, the licensee must take action to prevent human exposure to such RF electromagnetic fields. Further information on evaluating compliance with these limits can be found in the FCC's OET Bulletin 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields."

The Amateur Section of OET Bulletin Number 65:

In the FCC's Report and Order, certain amateur radio installations were made subject to routine evaluation for compliance with the FCC's RF exposure guidelines.[1] Also, amateur licensees will be expected to demonstrate their knowledge of the FCC guidelines through examinations. Applicants for new licenses and renewals also will be required to demonstrate that they have read and that they understand the applicable rules regarding RF exposure. Before causing or allowing an amateur station to transmit from any place where the operation of the station could cause human exposure to RF radiation levels in excess of the FCC guidelines amateur licensees are now required to take certain actions. A routine RF radiation evaluation is required if the transmitter power of the station exceeds the levels shown and specified in 47 CFR § 97.13(c)(1)[2] (see above). Otherwise the operation is categorically excluded from routine RF radiation evaluation, except as a result of a specific motion or petition as specified in Sections 1.1307(c) and (d) of the FCC's Rules, (see discussion in Section 1 of Bulletin 65 for more information).

The Commission's Report and Order instituted a requirement that operator license examination question pools will include questions concerning RF safety at amateur stations. An additional five questions on RF safety will be required within each of three written examination elements (for Novice, Technician and General written exams).

When routine evaluation of an amateur station indicates that exposure to RF fields are or could be in excess of the exposure limits specified by the FCC (see Bulletin 65, Appendix A {on reverse side}), the licensee must take action to correct the problem and ensure compliance (see Section 4 of Bulletin 65 on controlling exposure). Such actions could be in the form of modifying patterns of operation, relocating antennas, revising a station's technical parameters such as frequency, power or emission type or combinations of these and other remedies.

Bulletin 65, Appendix A, Table 1 -- LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Limits for Occupational/Controlled Exposure
(f = frequency in MHz *Plane-wave equivalent power density)

Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S)**	**Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)**
0.3-3.0	**614**	**1.63**	**(100)***	**6**
3.0-30	**1842/f**	**4.89/f**	**$(900/f^2)$***	**6**
30-300	**61.4**	**0.163**	**1.0**	**6**
300-1500	--	--	**f/300**	**6**
1500-100,000	--	--	**5**	**6**

Limits for General Population/Uncontrolled Exposure
(f = frequency in MHz *Plane-wave equivalent power density)

Frequency Range (MHz)	**Electric Field Strength (E) (V/m)**	**Magnetic Field Strength (H) (A/m)**	**Power Density (S) (mW/cm^2)**	**Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)**
0.3-1.34	**614**	**1.63**	**(100)***	**30**
1.34-30	**824/f**	**2.19/f**	**$(180/f^2)$***	**30**
30-300	**27.5**	**0.073**	**0.2**	**30**
300-1500	--	--	**f/1500**	**30**
1500-100,000	--	--	**1.0**	**30**

In complying with the Commission's Report and Order, amateur operators should follow a policy of systematic avoidance of excessive RF exposure. The Commission has said that it will continue to rely upon amateur operators, in constructing and operating their stations, to take steps to ensure that their stations comply with the MPE limits for both occupational/controlled and general public/uncontrolled situations, as appropriate. In that regard, amateur radio operators and members of their immediate household are considered to be in a "controlled environment" and are subject to the occupational/controlled MPE limits. Neighbors or others who are not members of an amateur operator's household are considered to be members of the general public, since they cannot reasonably be expected to exercise control over their exposure. In those cases general population/uncontrolled exposure MPE limits will apply.

In order to qualify for use of the occupational/controlled exposure criteria, appropriate restrictions on access to high RF field areas must be maintained and educational instruction in RF safety must be provided to individuals who are members of the amateur operator's household. Persons who are not members of the amateur operator's household but who are present temporarily on an amateur operator's property may also be considered to fall under the occupational/controlled designation provided that appropriate information is provided them about RF exposure potential if transmitters are in operation and such persons are exposed in excess of the general population/uncontrolled limits.

Amateur radio facilities represent a special case for determining exposure, since there are many possible antenna types that could be designed and used for amateur stations. However, several relevant points can be made with respect to analyzing amateur radio antennas for potential exposure that should be helpful to amateur operators in performing evaluations.

First of all, the generic equations described in Bulletin 65 can be used for analyzing fields due to almost all antennas, although the resulting estimates for power density may be overly-conservative in some cases. Nonetheless, for general radiators and for aperture antennas, if the user is knowledgeable about antenna gain, frequency, power and other relevant factors, the equations in this section can be used to estimate field strength and power density as described earlier. In addition, other resources are available to amateur radio operators for analyzing fields near their antennas. The ARRL Handbook For Radio Amateurs contains an excellent section on analyzing amateur radio facilities for compliance with RF guidelines. Also, the FCC and the EPA conducted a study of several amateur radio stations in 1990 that provides a great deal of measurement data for many types of antennas commonly used by amateur operators [3] (see the FCC OET Web site at: <http://www.fcc.gov/oet/info/documents/reports/#ASD-9601> see also <http://www.fcc.gov/oet/rfsafety/>).

Amateur radio organizations and licensees are encouraged to develop their own more detailed evaluation models and methods for typical antenna configurations and power/frequency combinations. The FCC has an Amateur Supplement "B" that is available from the FCC's OET Web site at: <http://www.fcc.gov/oet/rfsafety/>. Information on availability of the supplement, as well as other RF-related questions, can be directed to the FCC's "RF Safety Program" at: (202) 418-2464 or Email to: rfsafety@fcc.gov

See also: Sections 1 and 2 of the FCC Regulations; FCC's "Amateur" Supplement B to OET Bulletin 65; the ARRL's publication entitled "RF Exposure and You" (to be available in early 1998); the ARRLWeb at: <http://www.arrl.org/news/rfsafety/>; and our RF Safety article in January 1998 QST (Pages 50-55) for more information. FCC also has a very helpful Q&A discussing RF Biological Effects and Potential RF Hazards of RF Electromagnetic Fields - see "OET Bulletin 56, 4th Edition", published 8/99 <http://www.fcc.gov/oet/info/documents/bulletins/#56>.

[footnotes] -

1 See para. 160 of Report and Order, ET Dkt 93-62. See also, 47 CFR § 97.13, as amended.

2 These levels were chosen to roughly parallel the frequency of the MPE limits of Table 1 in Appendix A. These levels were modified from the Commission's original decision establishing a flat 50 W power threshold for routine evaluation of amateur stations (see Second Memorandum Opinion and Order, ET Docket 93-62, FCC 97-303, adopted August 25, 1997).

3 Federal Communications Commission (FCC), "Measurements of Environmental Electromagnetic Fields at Amateur Radio Stations," FCC Report No. FCC/OET ASD-9601, February 1996. FCC, Office of Engineering and Technology (OET), Washington, D.C. 20554. NTIS Order No. PB96-145016. Copies can also be downloaded from OET's Home Page on the World Wide Web at: <http://www.fcc.gov/oet/>

Worksheet A: Instructions — Categorical Exemption for Station Evaluation

Provided as a membership service by the American Radio Relay League, Inc., 225 Main St., Newington, CT 06111.

It is easy to determine if you need to do a routine station evaluation. The requirement to do a routine station evaluation is based on Table 1.1, showing peak envelope power (PEP) input to the antenna.

A, B, C: For your records, enter the call sign of the station (A) , the name of the station licensee (B) and station location (C) onto the top of the worksheet.

D. Enter the station operating frequency band being considered for evaluation (D).

E. Enter the maximum PEP output you use on that band (E).
(This can be determined by measurement or estimated from factors such as the rated output power of your transmitter. Alternatively, you can estimate from other factors. See Chapter 5, the section titled: "How to Calculate Peak Envelope Power to the Antenna.")

F, G. Enter your feed line type (F) and length (G).

H. Enter the specification for the loss in dB per 100 feet for your cable type. Use the manufacturer's specification or use the table in Chapter 5.

I. Divide the feed line length (G) by 100, then multiply the result by the specification for your feed line type for loss in dB per 100 feet. This will give you the total feed line loss in dB (I).

J. Enter the total feed line loss in dB (I) and convert it to a percentage (J).
(See the formulas or table in Chapter 5 or, optionally, you can use 0 dB for a conservative estimate. If you use 0 dB, skip to step J and enter 0%.)

K. Multiply the maximum transmitter PEP used on this band (E) by the percentage of power lost in the feed line (J). The result is the total power lost in the feed line (K).

L. Subtract the power lost in the feed line (K) from the transmitter PEP used on this band (E). The result is the PEP input to the antenna.

Compare the PEP input to the antenna (L) to the level in Table 1.1. If the power to the antenna is greater than the level in Table 1.1 for that frequency band, it will be necessary for you to perform a routine evaluation on your station. If your PEP to the antenna does not exceed the limits in Table 1.1, the rules do not require you to do a routine station evaluation on that band.

WORKSHEET A: CATEGORICAL EXEMPTION FOR STATION EVALUATION WORKSHEET

Provided as a membership service by the American Radio Relay League, Inc., 225 Main St., Newington, CT 06111.

Use this worksheet for each band you operate to determine if you need to do a station evaluation on that band.

(A): Station Call Sign: ________________ (B) Station Licensee: _________________________

(C) Station Location: ____

____

(D) Frequency Band: ____________

(E) Maximum Transmitter PEP used on this band: _______ W PEP

Refer to Table 1.1 — If the power on line (E) of this worksheet is less than or equal to the power limits given in the table for this band, you do not need to do an evaluation on this band. If the power exceeds the limits, continue with this worksheet.

Calculate Feed Line Loss in dB:

(F) Feed Line Type: __________________ (G) Feed Line Length: _________ ft

(H) Enter Feed Line Loss in dB per 100 ft: ______ dB

(From Chapter 5 or manufacturers specification. You can use 0 dB for a conservative estimate. If you use 0 dB, skip to step J and enter 0%.)

(G) ___________	/	100	×	(H) _______ dB	=	(I) _______ dB
Feed Line Length from (G)	divide by	100	then multiply by	loss in dB per 100 feet from (H)	equals	Feed Line Loss in dB

Convert to percentage:

(I) _________ dB	=	(J) _________ %
Feed Line Loss in dB from (I)		Convert to percentage of power lost in the feed line. See Chapter 5 or use 0% as a conservative estimate.

Power to antenna:

(E) _____________ W PEP	×	(J) _________ %	=	(K) _________ W PEP
Maximum transmitter PEP used on this band from (E)	times	Percentage of power lost in the feed line from (J)	equals	Power lost in the feed line

(E) ____________ W PEP	–	(K)___________ W	=	(L) ___________ W PEP
Maximum transmitter PEP used on this band from (E)	minus	Power lost in feed line	equals	PEP input to the antenna

Conclusion and decision:

Compare the power input to the antenna (L) to Table 1.1. If the power input to the antenna is less than or equal to this power level, you do not have to evaluate your station on this band.

Worksheet B: Instructions — Station Evaluation Worksheet

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If you do have to do a station evaluation for one or more powers or modes, use this worksheet to guide you through the process. This single page worksheet and instructions will suffice for many stations. See Chapter 5 for multiple transmitter sites and repeaters.

A, B. For your records, enter the call sign of the station (A), the station licensee (B) onto the top of the worksheet.

C. Enter the frequency band being evaluated.

D. Enter the operating mode being evaluated.

E. Enter the maximum transmitter peak-envelope power being used on this band (E). (See Chapter 5, the section titled: “How to Calculate Peak Envelope Power to the Antenna.”)

F. Enter the peak-envelope power input to the antenna from line L of Worksheet A (F).
(As a conservative first estimate, you can skip to steps J and K, using this power level.)

G. Enter the duty factor of the mode being evaluated (H):
(See the section in Chapter 5 titled: “Duty Factor,” or use 40% for CW, 20-40% for SSB, 100% for FM or digital modes.)

H,I. Enter the maximum percentage of time the station could be on the air for controlled or uncontrolled exposure. (A good rule of thumb is to use 100% for controlled exposure, 67% for uncontrolled exposure. Also see the table in Chapter 5.)

J, K. Calculate average power.
(Multiply the PEP input to the antenna (F) by the duty factor of the mode being used (G) by the operating time percentage (H, I). The result is the average power to the antenna.

L. Refer to any of the evaluation methods described in the FCC’s *OET Bulletin 65* of Chapter 5. Determine that the antenna is located far enough away from areas where people are present or that the field strength is below the maximum permissible exposure (MPE) limits in areas where people are present. Describe briefly the method used to perform this evaluation.

M. Record the results of your station evaluation. Your station evaluation for this band and mode is now complete. Although it is not required by FCC rules, it is recommended that you retain a copy of your station evaluation in your station records.

If the station is not in compliance under all circumstances of its expected operation, attach a separate sheet describing any limitations of methods that the station operator will use to ensure compliance if people are present in areas that could be out of compliance.

WORKSHEET B: STATION EVALUATION WORKSHEET

Provided as a membership service by the American Radio Relay League, Inc., 225 Main St., Newington, CT 06111.

Use this worksheet for each band, mode and antenna combination you use to determine if your station complies with the FCC regulations for RF exposure.

(A): Station Call Sign: ________________ (B) Station Licensee: _________________________

(C) Frequency Band: ____________ (D) Operating mode being evaluated: __________

(E) Maximum Transmitter PEP used on this band: ________ W PEP

(F) PEP input to the antenna on this band (from line (L) on Worksheet A): ________W PEP
For a conservative estimate, you could use your maximum transmitter PEP and skip to step (L) and use this power for your evaluation. If you "pass," you do not need to do the other steps.

Mode and duty factor:

(D) Operating mode being evaluated: _________ (G) Duty Factor for this mode: ______%
(See Chapter 5 or use 40% for CW, 20% for SSB with no speech processing, 40% for SSB with heavy speech processing, 100% for FM or digital modes)

Maximum time the station could be transmitting in:
(H) 6-min period (controlled): ____ / 6 = _____ %

(I) 30-min period (uncontrolled): ____ / 30 = _____ %

Calculate average power — Controlled exposure:

(F) ________ W PEP	×	(G) _______ %	×	(H) _______ %	=	(J) _______ W avg
PEP input to the antenna from (F)	times	Duty Factor from (G)	times	Controlled operating time percentage	equals	Controlled average power input to the antenna

Calculate average power — Uncontrolled exposure:

(F) ________ W PEP	×	(G) _______ %	×	(I) _______ %	=	(K) _______ W avg
PEP input to the antenna from (F)	times	Duty Factor from (G)	times	Uncontrolled operating time percentage	equals	Uncontrolled average power input to the antenna

(L) Refer to any of the evaluation methods in FCC's *OET Bulletin 65* or Chapter 5. Determine if the antenna is located far enough away from areas where people are present or that the field strength is below the maximum permissible exposure (MPE) limits, based on the frequency, mode, average power and antenna type being used.

(M) Describe the method used to do the evaluation: _________________________________

Using this method, did your station exceed the FCC RF exposure limits? (Y/N)

Controlled exposure: ___________(Y/N) Uncontrolled exposure: ____________ (Y/N)

If the station is not in compliance under all circumstances of its expected operation, attach a separate sheet describing any limitations of methods that the station operator will use to ensure compliance if people are present in areas that could be out of compliance.

Amateur Radio RF Safety Calculator

Calculation Results

Average Power at the Antenna	31.800 watts
Antenna Gain in dBi	7.20 dBi
Distance to the Area of Interest	30.00 feet
Frequency of Operation	29.000 MHz
Are Ground Reflections Calculated?	Yes
Estimated RF Power Density	0.0407 mw/cm^2

	Controlled Environment	**Uncontrolled Environment**
Maximum Permissible Exposure (MPE)	1.08 mw/cm^2	0.22 mw/cm^2
Distance to Compliance From Center of Antenna	5.90 feet	13.13 feet
Does the Area of Interest Appear to be in Compliance?	yes	yes

Interpretation of Resu

1. Remember that the power value entered into thes should be the average power seen at the antenna, Envelope Power (PEP). You may also consider fe calculating your average power at the antenna.

2. If you wish to estimate the power density at a poi main lobe of a directional antenna, and if the ante pattern is known, recalculate using the antenna's g relevant direction.

3. Please also consult FCC OET Bulletin 65 Supple Amateur Radio supplement to FCC OET Bulletin contains a thorough discussion of the RF Safety r they apply to amateur stations and contains nume tables, worksheets, and other data to help determi compliance.

Perform another compu

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Amateur Radio RF Safety Calculator

Calculation Results

Average Power at the Antenna	21.300 watts
Antenna Gain in dBi	7.20 dBi
Distance to the Area of Interest	46.00 feet
Frequency of Operation	29.000 MHz
Are Ground Reflections Calculated?	Yes
Estimated RF Power Density	0.0116 mw/cm^2

	Controlled Environment	Uncontrolled Environment
Maximum Permissible Exposure (MPE)	1.08 mw/cm^2	0.22 mw/cm^2
Distance to Compliance From Center of Antenna	4.84 feet	10.75 feet
Does the Area of Interest Appear to be in Compliance?	yes	yes

Interpretation of Resı

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