Official Technician License Question Pool w/ Explanations

T1 – Commission's Rules

T1A01 - Which of the following is part of the Basis and Purpose of the Amateur Radio Service? **Advancing skills in the technical and communication phases of the radio art**

Explanation: The FCC broadly defines the amateur radio services as an opportunity for self-training, intercommunication and technical investigations. This broad explanation is clearly defined in Part 97 of the rules and regulations in a brief legal description as "advancing skills in the technical and communication phases of the radio art." In plain English, this means getting on the air and having fun while improving your contesting skills, your traffic handling skills, your electronic and radio skills all while incorporating the latest technological advances into the amateur radio hobby. In other words, having fun!

T1A02 - Which agency regulates and enforces the rules for the Amateur Radio Service in the United States? **The FCC**

Explanation: In the United States, the Federal Communications Commission regulates amateur radio services. All amateur radio operators must have a license issued by the FCC before they are allowed to transmit. The FCC establishes the rules and regulations governing amateur radio operations. These regulations are in Part 97 of the commission's rules (47 C.F.R. Part 97).

T1A03 - What do the FCC rules state regarding the use of a phonetic alphabet for station identification in the Amateur Radio Service? **It is encouraged**

Explanation: Using a phonetic alphabet ensures the other amateur radio stations properly record your call sign and other important information in your transmissions. Using the phonetic alphabet during poor or difficult radio conditions on voice communications confirms the other amateur radio operator has recorded the correct information.

T1A04 - How many operator/primary station license grants may be held by any one person? **One**

Explanation: The primary station license and the amateur radio license are issued together. The FCC only grants one operator/primary station license to any one individual.

T1A05 - What proves that the FCC has issued an operator/primary license grant? **The license appears in the FCC ULS database**

Explanation: The operator/station license can be verified only in the FCC's database. The paper license issued by the FCC is a good document but does not reflect the current status of an amateur radio operator's license. For an amateur radio license to be valid, the status in the FCC's database must show as active, not revoked or canceled.

T1A06 - What is the FCC Part 97 definition of a beacon? **An amateur station transmitting communications for the purposes of observing propagation or related experimental activities**

Explanation: The signal strength of a beacon station is a good indicator of current band conditions without relying on charts or graphs that are only projections. Some hams use beacon stations in designing, building and testing their antenna systems. You can make quick adjustments on your system to see whether the signal from the beacon station has improved or diminished.

T1A07 - What is the FCC Part 97 definition of a space station? **An amateur station located more than 50 km above the Earth's surface**

Explanation: All transmitters on board an amateur radio space station must have the ability to be shut off by telecommands when ordered to do so by the FCC.

T1A08 - Which of the following entities recommends transmit/receive channels and other parameters for auxiliary and repeater stations? **Volunteer Frequency Coordinator recognized by local amateurs**

Explanation: Nearly every area in the United States that has amateur radio repeater coverage also has volunteer organizations to help with the coordination of frequencies and locations. The local repeater coordinator organization is recognized by the amateur radio operators in the area and works with other repeater coordinator organizations. These organizations provide guidelines for repeater physical locations and operating parameters. The organizations work hard to maximize the efficient use of our precious amateur radio frequencies. In cases where there are disputes, or the FCC is required to intervene, the FCC nearly always sides with the amateur radio repeater that has been coordinated through a recognized organization.

T1A09 - Who selects a Frequency Coordinator? A**mateur operators in a local or regional area whose stations are eligible to be repeater or auxiliary stations**

Explanation: Frequency coordinators for an area are chosen by the amateur radio operators in that area served by their repeater. Frequency coordinators work with other coordination groups to verify that your repeater will not cause interference to other repeaters and that your repeater has a good chance of being in the clear without interference as well. Frequency and/or repeater coordinators work with other groups across state lines to make sure interference is kept to an absolute minimum.

T1A10 - What is the Radio Amateur Civil Emergency Service (RACES)? A**ll of these choices are correct**

Explanation: RACES, or Radio Amateur Civil Emergency Service, is an emergency amateur radio service authorized by the FCC. The rules and regulations governing amateur radio operations for RACES are described in Part 97.407 of the FCC's rules and regulations. RACES usually

provides communications between government organizations while ARES, or the Amateur Radio Emergency Service, focuses on providing communications support to private organizations such as the American National Red Cross, Salvation Army, faith-based organizations, etc.

T1A11 - When is willful interference to other amateur radio stations permitted? **At no time**

Explanation: The FCC is very strict on the subject of "willful interference." FCC Rules Part 97 Section 101 (d) state: "No amateur operator shall willfully or maliciously interfere with or cause interference to any radio communication or signal." The FCC has the authority to impose fines, license suspension or revocation and prison time for these violations. To augment the FCC, the ARRL has implemented a Volunteer Monitor Program where amateurs are given training on how to identify "willful interference" and submit the proper observations and documentation to the FCC for legal action against the offenders. Willful interference can cause life-and-death situations when public service agencies such as police, fire and ambulance are prevented from performing their duties because of disrupted communications.

T1B01 - Which of the following frequency ranges are available for phone operation by Technician licensees? **28.300 MHz to 28.500 MHz**

Explanation: Amateur radio uses band plans to help share the different parts of bands where hams have privileges. Bands are broken up by mode (CW, Digital, Phone) and by license level. On 10 Meters, phone is allocated from 28.300 to 29.700 MHz, but Technicians are only allowed to use 28.300 to 28.500.

T1B02 - Which amateurs may contact the International Space Station (ISS) on VHF bands? **Any amateur holding a Technician or higher-class license**

Explanation: In the United States, the Technician class license is currently the entry level license. The Technician license class and above allows operator privileges on the 2-meter and 70-centimeter bands. Both of these bands allow communications with the International Space Station.

T1B03 - Which frequency is in the 6 meter amateur band? **52.525 MHz**

Explanation: In the United States, the amateur radio band for 6 meters covers from 50 to 54 MHz. Learning the frequencies and bands will come with time after operating on the bands for a little while. A good rule of thumb is to take 300,000,000 meters per second and divide by the frequency in MHz, yielding the wavelength. For example 300,000,000 divided by 50,000,000 Hz (50 MHz) = 6 meters, therefore 50 MHz is equal to the wavelength of 6 meters.

T1B04 - Which amateur band includes 146.52 MHz? **2 meter band**

Explanation: The international calling frequency for 2 meters is 146.520 MHz. Using the rule of thumb of 300,000,000 meters per second divided by the frequency in MHz yielding wavelength, we get 300,000,000 / 146,520,000 Hz = 2.04 meters or rounded to 2 meters. One

of the rules for taking the FCC exam is to choose the "most correct answer." You will see that given your choices, the 2 meter wavelength is the most correct or closest to the correct answer.

T1B05 - How may amateurs use the 219 to 220 MHz segment of 1.25 meter band? **Fixed digital message forwarding systems only**

Explanation: Some of the restrictions are amateur radio operators can use this band only for fixed digital message forwarding. Amateurs who still hold a Novice class license are not allowed to use these frequencies. Amateur operators must not cause interference to the existing users. Amateur radio equipment must be able to accept interference from the primary users of this frequency range and other adjacent bands. Amateur transmitters are limited to 50 watts PEP output and 100 kHz bandwidth. There are other restrictions in place that require permission from the primary users of these frequencies; please refer to the FCC Part 97.303(e) or ARRL publications before operating on these frequencies.

T1B06 - On which HF bands does a Technician class operator have phone privileges? **10 meter band only**

Explanation: There are excellent frequency allocation charts and graphs available from the ARRL for downloading. The General and Extra class licenses allow phone, or voice, privileges on nearly all amateur radio bands.

T1B07 - Which of the following VHF/UHF frequency ranges are limited to CW only?
50.0 MHz to 50.1 MHz and 144.0 MHz to 144.1 MHz

Explanation: Nearly all amateur radio band plans have areas reserved for only CW and digital emissions. After referring to one of the many band plan charts, you will slowly learn the sub band allocations by heart. Many radio manufacturers provide complimentary band plan charts at ham fests (ham radio flea markets) or by mail. The ARRL has several different designs available for downloading and printing, too.

T1B08 - How are US amateurs restricted in segments of bands where the Amateur Radio Service is secondary? **U.S. amateurs may find non-amateur stations in those portions, and must avoid interfering with them**

Explanation: The key word here is "secondary user." There are some bands in which amateur radio is not the sole user or primary user. As a secondary user on these shared bands, you need to be mindful of the fact other services are sharing their frequencies with us. You must not cause interference with these other users. You also may not cause willful or harmful interference with other non-amateur radio services.

T1B09 - Why should you not set your transmit frequency to be exactly at the edge of an amateur band or sub-band? **All of these choices are correct**

Explanation: The majority of hams choose an older radio as their first rig. Calibration on these radios is very good, but not exact. There are many volunteer monitors watching for out-of-band activity. A best practice is to not operate at the very band edge.

T1B10 - Where may SSB phone be used in amateur bands above 50 MHz? **In at least some segment of all these bands**

Explanation: Following the amateur radio band plan, all bands above 50 MHz allow for phone operation. Check the individual bands plan for the best location to use SSB phone.

T1B11 - What is the maximum peak envelope power output for Technician class operators in their HF band segments? **200 watts**

Explanation: Some amateur radio rules and regulations just have to be memorized; this is one of those rules. On HF, the Technician class license is limited to 200 watts PEP (peak envelope power). To help you memorize, HF is only two letters, therefore, the limit is 200 watts.

T1B12 - Except for some specific restrictions, what is the maximum peak envelope power output for Technician class operators using frequencies above 30 MHz? **1500 watts**

Explanation: There are a few specific restrictions, but for the most part, a Technician class licensee may operate on frequencies above 30 MHz using the full power authorized for amateur transmissions. This limit is 1,500 watts PEP.

T1C01 - For which license classes are new licenses currently available from the FCC? **Technician, General, Amateur Extra**

Explanation: The FCC currently is only issuing Technician, General and Extra class amateur licenses. When operating on the air, you will run into other operators who may hold a Novice or Advanced class license. These individuals are allowed to renew these license classes, but there are no new ones currently being issued.

T1C02 - Who may select a desired call sign under the vanity call sign rules? **Any licensed amateur**

Explanation: Any licensed amateur radio operator may select a vanity call sign. Your class of license determines which format of a vanity call sign you are eligible to receive. Currently, Technician and General class license holders may select the 1-by-3 call sign format (or the 2-by-3 format that new licensees generally are issued). Advanced class license holders can choose from available 2-by-2 formats (or 1-by-3 or 2-by-3 formats) while Extra class licensees can qualify for available 1-by-2, 2-by-1 or 2-by-2 formats, including all other formats.

T1C03 - What types of international communications is an FCC-licensed amateur radio station permitted to make? **Communications incidental to the purposes of the Amateur Radio Service and remarks of a personal character**

Explanation: You can eliminate three of these answers to find the correct one. No business communication is allowed with amateur radio, you can do more than contest on ham radio, and radio amateurs are not allowed to broadcast to the general public.

T1C04 - What may happen if the FCC is unable to reach you by email? **Revocation of the station license or suspension of the operator license**

Explanation: The FCC moved to email communications on June 29, 2021. The requirement states all amateurs "must have a current email address on file as part of their ULS record."

T1C05 - Which of the following is a valid call sign for a Technician class amateur radio station? **KF1XXX**

Explanation: Both Technician and General class license holders are eligible to select 1-by-3 call sign formats.

T1C06 - From which of the following locations may an FCC-licensed amateur station transmit? **From any vessel or craft located in international waters and documented or registered in the United States**

Explanation: The FCC regulates all amateur radio communications when operation occurs within the United States. However, amateurs holding a valid FCC-issued license may transmit from any vessel or craft located in international waters as long as the vessel or craft is documented or registered in the United States.

T1C07 - Which of the following can result in revocation of the station license or suspension of the operator license? **Failure to provide and maintain a correct email address with the FCC**

Explanation: The FCC moved to email communications on June 29, 2021. The requirement states all amateurs "must have a current email address on file as part of their ULS record."

T1C08 - What is the normal term for an FCC-issued primary station/operator amateur radio license grant? **Ten years**

Explanation: FCC Part 97.25(a) states: An amateur service license normally is granted for a 10-year term.

T1C09 - What is the grace period following the expiration of an amateur license within which the license may be renewed? **Two years**

Explanation: While you cannot operate once your license is expired, you have 2 years from the time of expiration to renew your amateur license without having to take an additional exam.

T1C10 - How soon after passing the examination for your first amateur radio license may you transmit on the amateur radio bands? **As soon as your operator/station license grant appears in the FCC's license database**

Explanation: Upon successfully passing your first amateur radio license exam, you may operate as soon as the license information has been updated in the FCC database. If you have upgraded from a previous amateur radio license, you start using your new privileges immediately. You must use the suffix "/AG" if you upgrade to a General class license or "/AE" if you upgrade to Extra class.

T1C11 - If your license has expired and is still within the allowable grace period, may you continue to transmit on the amateur radio bands? **No, you must wait until the license has been renewed**

Explanation: The FCC's definition of a "grace period" is referring to the fact you can simply renew your license without having to retake all the exams once again. The "grace period" does not mean that you can continue to operate your amateur radio transmitting equipment. Once your license expires, you are no longer allowed to transmit on ham frequencies. Renewal online using the FCC's website is fast and efficient.

T1D01 - With which countries are FCC-licensed amateur radio stations prohibited from exchanging communications? **Any country whose administration has notified the International Telecommunications Union (ITU) that it objects to such communications**

Explanation: FCC Part 97.111 allows amateur radio communications with other amateur stations in other countries, except when those countries have given notice to the International Telecommunications Union (ITU) that they object to such radio communications. There currently are no countries on the banned list as defined in 47
C.F.R. "97.111.

T1D02 - Under which of the following circumstances are one-way transmissions by an amateur station prohibited? **Broadcasting**

Explanation: Normally broadcasting one-way communications are prohibited; the exceptions are for using your amateur radio station to transmit code practice sessions, sending out information bulletins or any transmissions necessary to provide emergency communications. One-way communications are defined as one station transmitting to many receiving stations, such as done by a commercial radio or television station.

T1D03 - When is it permissible to transmit messages encoded to obscure their meaning? **Only when transmitting control commands to space stations or radio control craft**

Explanation: The FCC prohibits encoding or hiding the meaning of any message. The exception to this rule is when using control codes and commands that need to be ciphered or coded to prevent unauthorized users from controlling a radio control craft or space station.

T1D04 - Under what conditions is an amateur station authorized to transmit music using a phone emission? **When incidental to an authorized retransmission of manned spacecraft communications**

Explanation: The FCC strictly prohibits transmitting music from your amateur radio station. The only exception to this rule is when retransmitting audio from a manned spacecraft such as the space shuttle or the International Space Station. Occasionally Mission Control for the manned spacecraft will broadcast music to the crew such as wakeup calls and other special occasions.

T1D05 - When may amateur radio operators use their stations to notify other amateurs of the availability of equipment for sale or trade? **When selling amateur radio equipment and not on a regular basis**

Explanation: FCC rules and regulations prohibit using amateur radio for business or profit, but there is an exception with some restrictions. Amateur radio operators may offer their equipment for sale or trade providing this only occurs on an occasional basis.

T1D06 - What, if any, are the restrictions concerning transmission of language that may be considered indecent or obscene? **Any such language is prohibited**

Explanation: The FCC and ITU do not maintain a list of words that are considered "indecent or obscene." However, FCC Part 97 still prohibits any such language on amateur radio. Please keep in mind that the whole world listens to amateur radio transmissions. You are strongly urged to always keep your transmissions family safe. Be mindful of what you are saying; there are many ears listening.

T1D07 - What types of amateur stations can automatically retransmit the signals of other amateur stations? **Repeater, auxiliary, or space stations**

Explanation: FCC Part 97.3 (a)(7) allow transmitting communications point to point within a system of cooperating amateur radio stations. This does not include store and-forward messaging systems. Rules provide for repeater, auxiliary, space station or satellite operation for communications purposes.

T1D08 - In which of the following circumstances may the control operator of an amateur station receive compensation for operating that station? **When the communication is incidental to classroom instruction at an educational institution**

Explanation: FCC Part 97.113 (2) gives a list of prohibited transmissions, including communications for hire or for material compensation, direct or indirect, paid or promised, except as otherwise provided in these rules. However, FCC Part 97.113 (iii) states that teachers, as a control operator, may accept compensation when an amateur station is used by that teacher as a part of classroom instruction at an educational institution.

T1D09 - When may amateur stations transmit information in support of broadcasting, program production, or news gathering, assuming no other means is available? **When such**

communications are directly related to the immediate safety of human life or protection of property

Explanation: FCC Part 97.113 (b) clearly states an amateur radio station shall not engage in any form of broadcasting. However, there is an exception to this rule that says that communications directly related to the immediate safety of human life or the protection of property may be provided by an amateur radio station to broadcasters for dissemination to the public where no means of communications is reasonably available before or at the time of the event. In other words, if amateur radio operators have spotted a tornado on the ground headed toward a populated area, it is perfectly legal for the local TV station to rebroadcast ham communications to the general public in order to save human lives and property.

T1D10 - How does the FCC define broadcasting for the Amateur Radio Service? **Transmissions intended for reception by the general public**

Explanation: The FCC defines broadcasting as a one-way transmission to many receivers at the same time. This is no different than a local commercial radio or television station. Broadcasting is a one-way transmission to many receivers at the same time (such as a local AM or FM station or television station). Part 97.113 (b) strictly prohibits amateur radio stations to broadcast with a few exceptions. Two way communications is where both stations take turns transmitting and receiving.

T1D11 - When may an amateur station transmit without identifying on the air? **When transmitting signals to control model craft**

Explanation: FCC Part 97.119 states that each amateur radio station, except a space station or telecommand station, must transmit its assigned call sign on its transmitting channel at the end of each communication and at least every 10 minutes during a communication. The exception for a telecommand station includes sending commands to model craft such as radio control planes.

T1E01 - When may an amateur station transmit without a control operator? **Never**

Explanation: FCC Part 97.3 (13) defines a control operator as an amateur radio operator designated by the licensee of a station to be responsible for the transmissions from that station to assure compliance with FCC rules. There is no exception to this rule; you must always have a control operator responsible for operating your amateur radio station within the FCC's rules and regulations.

T1E02 - Who may be the control operator of a station communicating through an amateur satellite or space station? **Any amateur whose license privileges allow them to transmit on the satellite uplink frequency**

Explanation: FCC Part 97.207 (a) states that any amateur radio station may be a space station. Also, a holder of any class of amateur license may be the control operator of a space station, subject to the privileges of the class of operator held by the control operator. So providing you

have the privileges to transmit on the satellite's uplink frequency, you are eligible to be a control operator.

T1E03 - Who must designate the station control operator? **The station licensee**

Explanation: The amateur radio station license holder is who owns a station. Because it is their station, they can designate the control operator.

T1E04 - What determines the transmitting privileges of an amateur station? **The class of operator license held by the control operator**

Explanation: When operating your amateur radio station, the control operator determines the transmitting privileges. This is not a trick question; remember the control operator is the one who makes sure the station is operated within the FCC's rules.

T1E05 - What is an amateur station control point? **The location at which the control operator function is performed**

Explanation: The control point is where the control operator performs their functions.

T1E06 - When, under normal circumstances, may a Technician class licensee be the control operator of a station operating in an exclusive Amateur Extra class operator segment of the amateur bands? **At no time**

Explanation: The purpose of the control operator is to ensure the amateur radio station is operated within the FCC's rules. The control operator is responsible for proper operation of the amateur station within their operating privileges. At no time may a Technician class license holder allow operations outside of their operating privileges.

T1E07 - When the control operator is not the station licensee, who is responsible for the proper operation of the station? **The control operator and the station licensee**

Explanation: The control operator and the station licensee are equally responsible when the control operator is not the station licensee.

T1E08 - Which of the following is an example of automatic control? **Repeater operation**

Explanation: A repeater is an example of automatic control because there is a device managed by the trustee which monitors the repeater's performance and can shut it down or perform other management actions as needed. The other two options are just using the computer as a tool.

T1E09 - Which of the following are required for remote control operation? **All of these choices are correct**

Explanation: Remote control model cars, boats and aircraft operated by remote control and a control operator is directly operating these types of craft.

T1E10 - Which of the following is an example of remote control as defined in Part 97? **Operating the station over the internet**

Explanation: The FCC defines the control point where the control operator performs his functions. Remote operation does not mean that the control operator is away from their control point. The control operator must be at the control point at all times and the control operator indirectly controls the remote station.

T1E11 - Who does the FCC presume to be the control operator of an amateur station, unless documentation to the contrary is in the station records? **The station licensee** Explanation: Providing there is no documentation or information in the station's records clearly stating who the control operator is of a given amateur radio station; the FCC will assume that the license holder is the control operator.

T1F01 - When must the station licensee make the station and its records available for FCC inspection? **At any time upon request by an FCC representative**

Explanation: FCC Part 97.103 (c) states that the amateur radio station licensee must make the station and the station records available for inspection upon request by an FCC representative.

T1F02 - How often must you identify with your FCC-assigned call sign when using tactical call signs such as “Race Headquarters”? **At the end of each communication and every ten minutes during a communication**

Explanation: FCC Part 97.119 (a) clearly specifies that an amateur radio station must transmit their assigned call sign on its transmitting channel at the end of each communication, and at least every 10 minutes during your transmissions or conversation. So even though you are using tactical identifiers, you still have to give your FCC call sign every 10 minutes and at the end of your communication.

T1F03 - When are you required to transmit your assigned call sign? **At least every 10 minutes during and at the end of a communication**

Explanation: FCC Part 97.119 (a) clearly states than an amateur radio station must transmit its assigned call sign on its transmitting channel at the end of each communication and at least every 10 minutes.

T1F04 - What language may you use for identification when operating in a phone sub-band? **English**

Explanation: When talking with other stations, you are allowed to use any language you wish. FCC Part 97.119 (b) (2) requires that when using phone that the English language be used for

identification. The FCC strongly encourages using a phonetic alphabet as an aid for correct station identification.

T1F05 - What method of call sign identification is required for a station transmitting phone signals? **Send the call sign using a CW or phone emission**

Explanation: FCC Part 97.119 (b) (1) and (2) state that you may identify your station using either CW or phone. If using CW, the speed must be 20 words per minute or slower.

T1F06 - Which of the following self-assigned indicators are acceptable when using a phone transmission? **All of these choices are correct**

Explanation: FCC Part 97.119 (c) states that each self-assigned indicator must be separated from the call sign by the slant mark (/) or by any suitable word that denotes the slant mark. Using words such as "slant," "forward slant," "stroke" or "slash" are all acceptable words.

T1F07 - Which of the following restrictions apply when a non-licensed person is allowed to speak to a foreign station using a station under the control of a licensed amateur operator? **The foreign station must be in a country with which the U.S. has a third party agreement**

Explanation: Before you engage in third-party communications, verify the foreign country you are communicating with has a third-party agreement with the United States. The ARRL maintains a copy of the current list of approved countries.

T1F08 - What is the definition of third party communications? **A message from a control operator to another amateur station control operator on behalf of another person**

Explanation: FCC Part 97.3 (a) (47) defines third-party communications as a message from an amateur radio control operator (first party) of an amateur radio station to another amateur station control operator (second party) on behalf of another person (third party). This occurs every day, a good example is you have a non-licensed friend come over to your house. He sees your QSL cards from Spain and mentions that he is from Spain. You turn on your radio and contact a station from Spain. You give the microphone to your friend so he can talk to someone from his home country. Before you do this, you need to verify the United States has a third-party agreement with Spain. In this example, the United States DOES NOT have third-party agreements with Spain and you would be breaking U.S. federal law as well as laws in Spain.

T1F09 - What type of amateur station simultaneously retransmits the signal of another amateur station on a different channel or channels? **Repeater station**

Explanation: FCC Part 97.3 (a) (40) defines a repeater as an amateur station that simultaneously retransmits the transmission of another amateur station on a different channel or channels. As a newly licensed Technician class ham, you will enjoy extended-range repeaters generally on 2 meters, 1.25 meters and 70 centimeters.

T1F10 - Who is accountable if a repeater inadvertently retransmits communications that violate the FCC rules? **The control operator of the originating station**

Explanation: FCC Part 97.205 (g) clearly states that the control operator of a repeater that inadvertently retransmits communications that violate the rules is NOT accountable for the violative communications. The control operator of the amateur station that originates the violative communications will be held accountable.

T1F11 - Which of the following is a requirement for the issuance of a club station license grant? **The club must have at least four members**

Explanation: FCC Part 97.5 (b) (2) outlines the requirements for a club station license. The FCC will grant a club station license to a person who is the trustee designated by an officer of the club. The club also must be composed of at least four persons and must have a name, document of organization, management and a primary purpose devoted to amateur radio service activities consistent with FCC Part 97.

T2 – Operating Procedures

T2A01 - What is a common repeater frequency offset in the 2 meter band? **Plus or minus 600 kHz**

Explanation: This is not a trick question, but the two key words are "common" and "2 meter band." The most common offset used in the 2-meter band is minus 600 kHz or plus 600 kHz. In larger metropolitan areas, where frequency pairs are in high demand, you may find some non-standard offsets used to accommodate more repeaters. Other bands use a different offset frequency.

T2A02 - What is the national calling frequency for FM simplex operations in the 2 meter band? **146.520 MHz**

Explanation: This is another item that you will just have to memorize at first, but after a while this will become second nature. 146.520 MHz is the national calling frequency on the 2-meter band. You will see cars on the interstate with stickers on the back that say ".52 Call Me" and will have a call sign on the decal. The question asks for the 2-meter frequency, so you can rule out the two answers that have frequencies in the 440-MHz band.

T2A03 - What is a common repeater frequency offset in the 70 cm band? **Plus or minus 5 MHz**

Explanation: If you are listening to a repeater on 70cm, a common repeater frequency offset is plus or minus 5 MHz. For example, a repeater transmitting on 442.200, with a positive 5

megahertz offset, has a receive frequency of 447.200. Just like with other bands, you may see different offsets in larger metropolitan areas in order to accommodate more repeaters on the air.

T2A04 - What is an appropriate way to call another station on a repeater if you know the other station's call sign? **Say the station's call sign, then identify with your call sign**

Explanation: When you know the other amateur radio station's call sign, you just give their call sign and then identify your station with your call sign. For example, given your call sign is WB1XXX and the other ham's call is WB2XXX, you would say, "WB2XXX, this is WB1XXX."

T2A05 - How should you respond to a station calling CQ? **Transmit the other station's call sign followed by your call sign**

Explanation: Answering another station calling CQ is easy. Once you copy down the other operator's call sign, then you are ready to respond to their CQ. For example, given the station calling CQ is WB2XXX and your call sign is WB1XXX, to answer their CQ you would say, "WB2XXX, this is WB1XXX."

T2A06 - Which of the following is required when making on-the-air test transmissions? **Identify the transmitting station**

Explanation: As with all transmissions, the FCC requires that you must identify your station when transmitting. When performing on-the-air test transmissions, you must identify your amateur station with your call sign.

T2A07 - What is meant by "repeater offset?" **The difference between a repeater's transmit frequency and its receive frequency**

Explanation: The "repeater offset" is the difference between the repeater's transmit frequency and its receive frequency. The transmit frequency can either be above or below the repeater's receive frequency.

T2A08 - What is the meaning of the procedural signal "CQ"? **Calling any station**

Explanation: This is the process where you make a general call to any other amateur station. A good rule of thumb is to call CQ three times and then give your call sign three times. If you are using phone, it is always a good idea to use a widely recognized phonetic alphabet when giving your call sign. An example would be: "CQ CQ CQ. This is WB1XXX, Whiskey Bravo One X-ray X-ray X-ray."

T2A09 - Which of the following indicates that a station is listening on a repeater and looking for a contact? **The station’s call sign followed by the word “monitoring”**

Explanation: For the most part, calling CQ on a repeater is considered a poor practice. The preferred method is to key up the repeater and give your call sign. Giving your call sign phonetically is a good idea if you are not well known in the area or just received your Technician license. In larger cities, you sometimes will hear a station give their call sign followed by the repeater's frequency and the word "monitoring." This is because larger cities have many repeaters and many hams scan multiple repeaters with their radios. So if they hear your call sign and want to return your call, they will not know which repeater you made the call from. In addition to using the frequency when calling out on a repeater, you also might here the repeater referred to by a geographic location, such as a mountaintop name or a community name, such as: "N1USA listening Cherryville" or "N1USA listening Mount Washington." "Listening" is the same as "monitoring."

T2A10 - What is a band plan, beyond the privileges established by the FCC? **A voluntary guideline for using different modes or activities within an amateur band**

Explanation: The band plans specify what modes of operations -- such as voice, digital and/or CW -- are used on what frequencies. A band plan indicates, according to local needs, what modes of operations (voice, packet, etc.) are used on what frequencies. Many amateur radio equipment manufacturers and ham organizations have really nice band plan charts you can either obtain directly or download from the web. The ARRL is an excellent source of amateur radio operating aids.

T2A11 - What term describes an amateur station that is transmitting and receiving on the same frequency? **Simplex**

Explanation: Simplex operation defines an amateur station that is transmitting and receiving on the same frequency. Sometimes you will hear hams asking you to go to the repeater's transmit frequency on simplex. An example would be: "WB1XXX, this is WB2XXX. Joe, please go to 146.94 simplex." The national calling frequency, 146.52 MHz, is used on a simplex basis.

T2A12 - What should you do before calling CQ? **All of these choices are correct**

Explanation: Before calling CQ, you first must listen on the frequency you have selected to use. By listening, you can verify whether anyone is currently using the frequency. Next you must identify your station and ask whether the frequency is in use. There may be an emergency operations activity in progress that you cannot hear, particularly both sides of the conversation. Asking whether the frequency is in use with your call sign will make sure you are not going to cause interference. Then as the last step, double check that the frequency you have chosen is within your assigned privileges for the band as well as designated uses within the band plan.

T2B01 - How is a VHF/UHF transceiver's "reverse" function used? **To listen on a repeater's input frequency**

Explanation: This is very handy in case of an emergency. You can drive to a small hill or mountain and put your radio into the "reverse split" mode if your repeater is off the air due to

the emergency. This way everyone can still talk to the net control station during the emergency, and not have to reprogram their radio or try and figure out what other backup frequency to use when the repeater is off the air. It also might help in a situation where another operator is outside the range of the repeater, but possibly could be close enough to you and you hear that station on the input. You then can communicate with that station using "reverse."

T2B02 - What term describes the use of a sub-audible tone transmitted along with normal voice audio to open the squelch of a receiver? **CTCSS**

Explanation: This means that the repeater's squelch will be opened only by a transmitter that transmits the proper sub-audible tone. This technique was developed and implemented by Motorola under the name "Private Line" or PL. Many modern radios and programming software refer to this sub-audible tone as CTCSS, or Continuous Tone-Coded Squelch System. The FCC is looking for the term CTCSS when referring to PL tones and codes. There also are digital codes that aren't subaudible but work in the same way and are known as Digital Code Squelch, or DCS. The Motorola term for DCS is "Digital Private Line," or DPL.

T2B03 - Which of the following describes a linked repeater network? **A network of repeaters in which signals received by one repeater are transmitted by all the repeaters in the network**

Explanation: A linked repeater network is a network of repeaters where signals received by one repeater are repeated by all the repeaters. There's a popular repeater network in California called the PAPA network that allows users to talk up and down the coast from home or with handheld and mobile radios.

T2B04 - Which of the following could be the reason you are unable to access a repeater whose output you can hear? **All of these choices are correct**

Explanation: Sometimes you can hear a repeater perfectly fine, but you are unable to transmit through the repeater. Common problems are that you are using the wrong transmit/receive offset, you have the incorrect CTCSS tone or you may have the incorrect DCS code. A quick check with the repeater owners, maybe the repeater owner's website or repeater directories or other stations using the repeater will get you the correct information in short order.

T2B05 - What would cause your FM transmission audio to be distorted on voice peaks? **You are talking too loudly**

Explanation: Many times you will hear an amateur station having difficulty getting into the repeater, especially on their voice peaks. This usually is caused by the other station over deviating their transmitter. By the nature of FM operating characteristics, the louder you talk the more your frequency changes. By speaking softer into the microphone, your transmitted signal's deviation will be reduced as well as the condition of chopping in and out of the repeater.

T2B06 - What type of signaling uses pairs of audio tones? **DTMF**

Explanation: Sometimes you'll hear Touch-Tones over a radio. Those are DTMF (dual tone, multi-frequency) audio tones, for signaling repeaters or other equipment.

T2B07 - How can you join a digital repeater's "talk group"? **Program your radio with the group's ID or code**

Explanation: DMR (Digital Mobile Radio) communications use "talk groups" in order to talk with other amateurs. To access a given talk group, you first must program that talk group ID into your radio's parameters, sometimes referred to as a code plug. Yes, everyone still needs to be in the same talk group, even when operating simplex. There are thousands of different talk groups; some are for specific topics while others cover a specific geographical area or location.

T2B08 - Which of the following applies when two stations transmitting on the same frequency interfere with each other? **The stations should negotiate continued use of the frequency**

Explanation: When using HF, it is very common for propagation conditions to change over the course of a few minutes. When this occurs, you may find other amateurs using the same frequency you have been using. In these cases, it's best to let common courtesy prevail and work out a solution. Remember, no amateur "owns" a given frequency. Please share and strive to get along with one another. The whole world can listen to your behavior on the air.

T2B09 - Why are simplex channels designated in the VHF/UHF band plans? **So stations within range of each other can communicate without tying up a repeater**

Explanation: Simplex frequencies are designated in VHF and UHF band plans so stations within close communications range can communicate without tying up repeaters. This works when both or all stations are within range of each other. This allows the repeaters to be used for those who are not within range of each other.

T2B10 - Which Q signal indicates that you are receiving interference from other stations? **QRM**

Explanation: When first getting started in amateur radio, you quickly will find out many operators use a lot of different abbreviations in their conversations. Nearly all of these originated from CW operations, where it was important to keep your transmissions as short as possible by using common abbreviations. The Q signals are one example of these abbreviations; you will learn them after operating on the air for a short while, especially using CW. QRM refers to man-made interference from other amateur stations. QRN refers to interference due to static.

T2B11 - Which Q signal indicates that you are changing frequency? **QSY**

Explanation: QSY means you are changing frequency. You can remember this because frequency ends in Y, much like this Q code.

T2B12 - What is the purpose of the color code used on DMR repeater systems? **Must match the repeater color code for access**

Explanation: On Digital Mobile Radio (DMR) repeaters, color codes are similar to CTCSS and DCS on analog repeaters. The color code you transmit on your radio must match the repeater's color code in order to access the repeater and have it retransmit your signal.

T2B13 - What is the purpose of a squelch function? **Mute the receiver audio when a signal is not present**

Explanation: The squelch function on your radio mutes the receiver audio when there is no signal present. If you don't set the squelch on your radio, you would hear static even in the absence of communications in progress.

T2C01 - When do FCC rules NOT apply to the operation of an amateur station? **FCC rules always apply**

Explanation: Over the years, there has been false information given out about the FCC's jurisdiction. Sometimes you will hear comments such as: "FCC rules do not apply to me now. I am operating under RACES rules." The FCC governs all radio frequencies in the United States. The FCC's rules and regulations apply at all times.

T2C02 - Which of the following are typical duties of a Net Control Station? **Call the net to order and direct communications between stations checking in**

Explanation: The typical duties of a net control station (NCS) are to call the net to order on the air and direct communications between stations that check in for the net.

T2C03 - What technique is used to ensure that voice messages containing unusual words are received correctly? **Spell the words using a standard phonetic alphabet**

Explanation: The propagation between two amateur stations is not always perfect and sometimes atmospheric conditions make communications difficult. When using voice modes, you are encouraged to use a phonetic alphabet to spell strange or unusual words, names, locations, etc., to ensure the voice message is received correctly.

T2C04 - What is RACES? **An FCC part 97 amateur radio service for civil defense communications during national emergencies**

Explanation: Many individuals join the ranks of the amateur community to help and assist with emergency communications. Two of the largest such communications organizations are RACES and ARES. RACES (Radio Amateur Civil Emergency Service) provides emergency communications solely to government agencies and elected officials. ARES (Amateur Radio Emergency Service) deals primarily with private organizations such as the American National

Red Cross, the Salvation Army, etc. Both RACES and ARES provide valuable communications during emergencies.

T2C05 - What does the term "traffic" refer to in net operation? **Messages exchanged by net stations**

Explanation: Amateur radio nets allow for a number of amateurs to use a single frequency. The use of nets allows for efficient use of our frequency privileges. There are many different types of nets. Some are for weather, antique cars, model railroads and more. One type of net is traffic nets. These are nets that are designed to exchange formal messages between different stations. The word "traffic" refers to formal messages. These types of nets were very popular up until the early 1980s.

T2C06 - What is the Amateur Radio Emergency Service (ARES)? **A group of licensed amateurs who have voluntarily registered their qualifications and equipment for communications duty in the public service**

Explanation: The Amateur Radio Emergency Service, or ARES, is a group of licensed amateurs who have voluntarily registered their qualifications and radio equipment for communications duty in the public service.

T2C07 - Which of the following is standard practice when you participate in a net? **Unless you are reporting an emergency, transmit only when directed by the net control station**

Explanation: After checking into a net, you are to remain on frequency without transmitting until you are asked to do so by the net control station. After a group of amateur operators check into the net, the NCS will acknowledge who has checked in to the net. If your call sign was not mentioned, then you can check in again and avoid conflicting with other stations when you transmit. If for some reason you need to leave the net before it terminates, wait until there is a pause in the net, give your call sign and request to secure your station. This is important in traffic nets because the net control may direct formal messages to your station and you would have left long before.

T2C08 - Which of the following is a characteristic of good traffic handling? **Passing messages exactly as received**

Explanation: The National Traffic System takes great pride in the fact the messages that travel through their system are received exactly as they were sent. Many of the prosigns used today came from the formal traffic and message handling procedures. Each message has a "check" that is used to validate the number of words or groups in a formal message. The characteristic of good traffic handling is passing the messages exactly as they were received.

T2C09 - Are amateur station control operators ever permitted to operate outside the frequency privileges of their license class? **Yes, but only in situations involving the immediate safety of human life or protection of property**

Explanation: Only under extreme situations are amateur radio control operators permitted to operate outside the frequency privileges of their license class. Operating outside the privileges of your license class is permitted, but only if necessary in situations involving the immediate safety of human life or protection of property.

T2C10 - What information is contained in the preamble of a formal traffic message? **Information needed to track the message**

Explanation: Every formal message passed over amateur radio has a predetermined format. The preamble of the formal message contains the information needed to track the message. The preamble includes information such as the amateur station that sent the message, the station that received the message, the message number, etc.

T2C11 - What is meant by “check” in a radiogram header? **The number of words or word equivalents in the text portion of the message**

Explanation: One of the pieces of information in a formal message is the "check." The check in a formal message is the number of words or word equivalents in the text portion of the message. This "check" ensures the integrity of the messages being sent through the National Traffic System. When the receiving station performs the check -- and it is different from what is in the message -- they immediately know they have copied something incorrectly in the message.

T3 – Radio Waves

T3A01 - Why do VHF signal strengths sometimes vary greatly when the antenna is moved only a few feet? **Multipath propagation cancels or reinforces signals**

Explanation: When using a handheld or mobile 2-meter radios, sometimes moving the radio or the vehicle a few feet will make the difference from being received perfectly by the other station to a very distorted signal. If the receiving station reports that your 2-meter signal was strong just a moment ago but now it is weak or distorted, usually moving the radio or the mobile station a few feet will improve your signal. Many times the signals are reflected and may cause multipath distortion of your signals.

T3A02 - What is the effect of vegetation on UHF and microwave signals? **Absorption**

Explanation: Vegetation, like leaves, causes absorption of UHF and microwave signals. Yes, those leaves on trees between two UHF or microwave stations can absorb and degrade your signal.

T3A03 - What antenna polarization is normally used for long-distance weak-signal CW and SSB contacts on the VHF and UHF bands? **Horizontal**

Explanation: On the VHF and UHF bands, horizontally polarized antennas are normally better for long-distance weak-signal CW and SSB contacts.

T3A04 - What happens when antennas at opposite ends of a VHF or UHF line of sight radio link are not using the same polarization? **Received signal strength is reduced**

Explanation: Given two stations using the VHF or UHF bands for line-of-sight radio links, if one station is vertically polarized and the other station is horizontally polarized, the signals could be significantly weaker.

T3A05 - When using a directional antenna, how might your station be able to communicate with a distant repeater if buildings or obstructions are blocking the direct line of sight path? **Try to find a path that reflects signals to the repeater**

Explanation: There are many obstructions that can affect VHF and UHF electromagnetic radio waves, such as buildings with foil-backed insulation, metal roofs and steel structures. Unlike an omnidirectional antenna that radiates equally in all directions, a directional antenna can focus most of its signal in one direction. By changing the direction in which your directional antenna is pointing, you can find a path that reflects your signals to the repeater.

T3A06 - What is the meaning of the term “picket fencing”? **Rapid flutter on mobile signals due to multipath propagation**

Explanation: When studying for your Technician license, you have seen references to conditions when moving your antenna just a few feet one direction or the other makes the difference from being heard or not. Now apply these conditions while you are mobile transmitting from your vehicle while moving. The station receiving your signal sometimes hears a rapid fluttering signal from you. Think about shining a light through a picket fence while walking down the sidewalk. The rapid on/off of the light is the way the radio signal sounds. This is where the term "picket fencing" originated.

T3A07 - What weather condition might decrease range at microwave frequencies? **Precipitation**

Explanation: If you are using microwave frequencies, such as those in the upper UHF band, you may see decreased range if you are transmitting while it is raining.

T3A08 - What is a likely cause of irregular fading of signals propagated by the ionosphere? **Random combining of signals arriving via different paths**

Explanation: Radio waves are not a single beam of energy that goes from your station to another station. The radio waves can take multiple paths to go from one point to another. One

example is that part of your signal is going directly to the other station, while another part of your signal is bouncing off a building before it arrives at the other station. The random combining of these signals arriving via different paths causes irregular fading.

T3A09 - Which of the following results from the fact that signals propagated by the ionosphere are elliptically polarized? **Either vertically or horizontally polarized antennas may be used for transmission or reception**

Explanation: The elliptically polarized signals contain properties of both vertical and horizontal polarization. Because of this distortion from the original polarization, either a vertically or horizontally polarized antenna may be used for transmitting or receiving.

T3A10 - What effect does multi-path propagation have on data transmissions? **Error rates are likely to increase**

Explanation: Many times, the analog voice or CW signals will sound like they are underwater or have a slight echo. When listening to analog audio signals that have arrived via multiple paths, our brain has the ability to fill in the gaps of missing words or distorted words. With digital data signals being distorted by this condition, the computer can't fill in the gaps. In this case, your error rate will start to increase as the signal quality decreases.

T3A11 - Which region of the atmosphere can refract or bend HF and VHF radio waves? **The ionosphere**

Explanation: The upper layer of the atmosphere that becomes ionized when exposed to radiation from the sun is called the Ionosphere. When radio waves transmitted by an amateur transmitter reach the ionosphere, they bounce back to earth to be received by another station many miles away, or in some cases many thousands of miles away -- or around the world.

T3A12 - What is the effect of fog and rain on signals in the 10 meter and 6 meter bands? **There is little effect**

Explanation: Radio waves, or RF energy, are absorbed by water and solids. The energy absorbed by the moisture is converted to heat. As you go higher in frequency, this absorption property becomes more and more of a problem. This is well documented in microwave frequencies from years of commercial applications. For 10-meter and 6-meter wavelengths, the frequency isn't high enough to be affected by fog and light rain. Thus, fog and light rain will have little effect on those amateur bands.

T3B01 - What is the relationship between the electric and magnetic fields of an electromagnetic wave? **They are at right angles**

Explanation: A radio wave has two components: the electric and magnetic fields. The two fields of an electromagnetic wave are at right angles to each other.

T3B02 - What property of a radio wave defines its polarization? **The orientation of the electric field**

Explanation: A radio wave contains two properties, electric waves and magnetic waves, therefore the name "electromagnetic waves." The property of the electric field is used to describe the polarization. So just remember radio waves travel at the speed of light and the polarization does not affect the speed of the radio waves. Other distractors such as the ratio of velocity to wavelength has no effect on the polarization.

T3B03 - What are the two components of a radio wave? **Electric and magnetic fields**

Explanation: But these two different properties work together to create a resonate circuit.

T3B04 - What is the velocity of a radio wave traveling through free space? **At the speed of light**

Explanation: For most all amateur radio calculations, we will use the constant of 300,000 kilometers per second for formulas requiring the speed of light.

T3B05 - What is the relationship between wavelength and frequency? **The wavelength gets shorter as the frequency increases**

Explanation: There is a direct relationship between the wavelength of radio waves and frequency. As the wavelength gets shorter, the frequency increases -- just like the strings on a musical instrument where the shorter the string the higher the frequency of the note.

T3B06 - What is the formula for converting frequency to approximate wavelength in meters? **Wavelength in meters equals 300 divided by frequency in megahertz** Explanation: Amateur radio operators refer to frequency bands in meters. For instance, the 144-148 MHz band is the 2-meter band, while the 28-29.7 MHz band is 10 meters. Here's how to convert megahertz to wavelength in meters: Take 300 and divide it by the frequency in megahertz, so for 146 MHz, its 300 divided by 146 = 2.05, or 2 meters!

T3B07 - In addition to frequency, which of the following is used to identify amateur radio bands? **The approximate wavelength in meters**

Explanation: The approximate wavelength of the various frequency bands used by ham radio operators often is used to identify the bands. For instance, frequencies in the 144-148 MHz band used by hams often is called the 2-meter band, which is a reference to the 2-meter wavelength of radio signals on that band.

T3B08 - What frequency range is referred to as VHF? **30 MHz to 300 MHz**

Explanation: The VHF (very high frequency) radio spectrum refers to radio waves with a frequency of 30 MHz to 300 MHz. The wavelength of this radio spectrum is 10 meters to 1 meter.

T3B09 - What frequency range is referred to as UHF? **300 to 3000 MHz**

Explanation: The UHF (ultra-high frequency) radio spectrum refers to radio waves with a frequency of 300 MHz (megahertz) to 3 GHz (gigahertz). Sometimes you will see 3 GHz referred to as the "decimeter band." Wavelengths in the UHF radio spectrum range from one meter to one tenth of a meter (one decimeter).

T3B10 - What frequency range is referred to as HF? **3 to 30 MHz**

Explanation: The HF (high frequency) radio spectrum refers to radio waves with a frequency of 3 MHz to 30 MHz. The wavelength of this spectrum is 100 meters to 10 meters.

T3B11 - What is the approximate velocity of a radio wave in free space? **300,000,000 meters per second**

Explanation: On amateur exams, the constant of 300 million meters per second will be used for the speed of light.

T3C01 - Why are simplex UHF signals rarely heard beyond their radio horizon? **UHF signals are usually not propagated by the ionosphere**

Explanation: Signals on UHF frequencies rarely are heard from stations outside their local area because these frequencies usually are not reflected by the ionosphere.

T3C02 - What is a characteristic of HF communication compared with communications on VHF and higher frequencies? **Long distance ionospheric propagation is far more common on HF**

Explanation: The amateur radio VHF and UHF and above bands are mostly for communications with other stations that are within line of sight. These bands depend on repeaters to increase their effective range. The HF bands are well suited for long-range communications because their radio waves are reflected back toward earth instead of punching through the ionosphere. The ability of HF frequencies to bounce off the ionosphere and provide long-distance propagation is far more common.

T3C03 - What is a characteristic of VHF signals received via auroral backscatter? **They are distorted and signal strength varies considerably**

Explanation: VHF signals reflected off an aurora tend to sound distorted with a rapid fluctuation of signal strength.

T3C04 - Which of the following types of propagation is most commonly associated with occasional strong signals on the 10, 6, and 2 meter bands from beyond the radio horizon? **Sporadic E**

Explanation: Sometimes you will hear amateur stations located past the horizon on 10 meters, 6 meters and 2 meters with strong signals. These over-the-horizon signals are being reflected by the E layer of the atmosphere. This propagation type is called sporadic E.

T3C05 - Which of the following effects may allow radio signals to travel beyond obstructions between the transmitting and receiving stations? **Knife-edge diffraction**

Explanation: Radio waves are not a single beam of energy going from one amateur station to another. Radio waves can take many different directions between any given two stations. Sometimes reliable two-way communications can be accomplished between two stations despite obstructions between them. This propagation type is called knife-edge diffraction.

T3C06 - What type of propagation is responsible for allowing over-the-horizon VHF and UHF communications to ranges of approximately 300 miles on a regular basis? **Tropospheric ducting**

Explanation: Sometimes you can have reliable communications on VHF and UHF with other amateur stations that are over-the-horizon approximately 300 miles away on a regular basis. This propagation mode is called tropospheric ducting. These conditions can occur at any given time, but are more common during the summer and autumn.

T3C07 - What band is best suited for communicating via meteor scatter? **6 meter band**

Explanation: Communications via meteor scatter occurs when radio waves are reflected back to Earth from the ionized atmosphere because meteorites are entering Earth's atmosphere and burning up on entry. The 6-meter, or 50 MHz, band is excellent for meteor scatter communications because of its wavelength.

T3C08 - What causes tropospheric ducting? **Temperature inversions in the atmosphere**

Explanation: Sometimes warmer air becomes trapped above cooler air. This is called temperature inversion or thermal inversion. This atmospheric condition allows for a condition called tropospheric ducting.

T3C09 - What is generally the best time for long-distance 10 meter band propagation via the F layer? **From dawn to shortly after sunset during periods of high sunspot activity**

Explanation: Each amateur band has its own characteristics and personalities. As you spend time operating and communicating with other amateurs on each of these bands, you will learn the capabilities and limitations of each one. The 10-meter band follows the sun and thus is best in daylight hours when the sun has created the maximum amount of ionization in the

ionosphere. So during periods of high sunspot activity, 10 meters will be useful from dawn to shortly after sunset. 6 meters often is referred to as the "magic band."

T3C10 - Which of the following bands may provide long-distance communications via the ionosphere's F region during the peak of the sunspot cycle? **6 or 10 meter bands**

Explanation: Once again, this is a question that you must read a couple of times to actually understand what the FCC is asking on your test. The key words here are "sunspot cycle." So out of the given list of bands to choose from, which amateur bands are affected by the sunspot cycle. Most VHF and UHF frequencies pass right through the ionosphere and into space. The lower frequencies or longer wavelength amateur bands tend to be reflected back to Earth, where they are received long distances from your location. From the list of given distractors, the 6- and 10-meter bands are the correct choice. The other frequencies offered as choices are ones that penetrate the ionosphere and continue into space.

T3C11 - Why is the radio horizon for VHF and UHF signals more distant than the visual horizon? **The atmosphere refracts radio waves slightly**

Explanation: The radio horizon for VHF and UHF signals is more distant than the visual horizon because VHF and UHF frequencies can follow the Earth's curvature and travel farther than we can see. The Earth seems less curved to radio waves than to light waves. Basically, if you can "see" the other amateur station, then you probably can communicate with them on VHF or UHF.

T4 – Radio Practices

T4A01 - Which of the following is an appropriate power supply rating for a typical 50 watt output mobile FM transceiver? **13.8 volts at 12 amperes**

Explanation: For a typical 50-watt output mobile FM transceiver, an appropriate power supply rating would be 13.8 volts at 12 amperes. When shopping for a power supply to run your transceiver, first look at the specification of the radio. What does the manufacturer state as the maximum current? If their radio is a 50-watt radio at 12 volts, then a 10-ampere power supply is sufficient. (12 volts X 10 amperes = 120 watts, which is greater than the 50 watts of the radio). There are other factors to consider, but this information helps address this question on the exam.

T4A02 - Which of the following should be considered when selecting an accessory SWR meter? **The frequency and power level at which the measurements will be made**

Explanation: SWR meters are calibrated for use on different frequency bands, so be sure the meter you acquire can handle the frequencies and power level you want to measure. If you are

transmitting with a 50-watt radio on the 2-meter band, be sure your SWR meter covers the 144-148 MHz 2-meter band and can accommodate 50 watts transmitting through the meter.

T4A03 - Why are short, heavy-gauge wires used for a transceiver's DC power connection? **To minimize voltage drop when transmitting**

Explanation: In all cases, you want to avoid the operating voltage falling below that needed for proper operation of the radio.

T4A04 - How are the transceiver audio input and output connected in a station configured to operate using FT8? **To the audio input and output of a computer running WSJT-X software**

Explanation: A station operating using the FT8 digital mode should have the transceiver's audio output and input connected to the audio input and output of a computer running WSJT-X software.

T4A05 - Where should an RF power meter be installed? **In the feed line, between the transmitter and antenna**

Explanation: An RF power meter used in your station should be connected in series with the feed line, between the transmitter and the antenna.

T4A06 - What signals are used in a computer-radio interface for digital mode operation? **Receive audio, transmit audio, and transmitter keying**

Explanation: The signals used in a computer-radio interface for digital mode operation require that three connections be made between the computer and the radio. Connect the receive audio, transmit audio and transmitter keying between the transceiver and a computer to make it function.

T4A07 - Which of the following connections is made between a computer and a transceiver to use computer software when operating digital modes? **Computer "line in" to transceiver speaker connector**

Explanation: To use computer software when operating digital modes, you connect the computer "line in" to the transceiver's speaker connector so the computer can hear what is being sent on the radio.

T4A08 - Which of the following conductors is preferred for bonding at RF? **Flat copper strap**

Explanation: A flat copper strap is preferred for bonding at RF. The flat copper strap provides the lowest impedance to RF signals, effectively providing a direct route to ground potential.

T4A09 - How can you determine the length of time that equipment can be powered from a battery? **Divide the battery ampere-hour rating by the average current draw of the equipment**

Explanation: Divide the battery ampere-hour rating by the average current draw of the equipment to determine the length of time that equipment can be powered from a battery.

T4A10 - What function is performed with a transceiver and a digital mode hot spot? **Communication using digital voice or data systems via the internet**

Explanation: A digital mode hot spot allows hams using digital radios such as DMR or D-STAR to communicate on digital voice or data systems via the internet while at home (or mobile). A hot spot like a Raspberry Pi acts as a repeater for those nodes, retransmitting the signal from the radio onto the internet and back from other users to the radio.

T4A11 - Where should the negative power return of a mobile transceiver be connected in a vehicle? **At the 12 volt battery chassis ground**

Explanation: The negative power cable to your radio should be connected to the battery or the engine block ground strap. The battery or the engine block ground strap is the answer the FCC is expecting for this question. In real life, please consult with the vehicle's manufacturer if unsure. Some newer vehicles use the negative battery connection to determine current drain, thus your radio connection might cause inaccurate readings or problems. Many electric vehicles have voltages in excess of 12 volts flowing through some wiring harnesses. If unsure, please consult with an expert or professional.

T4A12 - What is an electronic keyer? **A device that assists in manual sending of Morse code**

Explanation: An electronic keyer can be used while operating CW to assist in the manual sending of Morse code.

T4B01 - What is the effect of excessive microphone gain on SSB transmissions? **Distorted transmitted audio**

Explanation: If you are told that your transmitted audio is distorted when operating on SSB, it most likely is the result of excessive microphone gain. Good audio helps other stations hear you better on the air.

T4B02 - Which of the following can be used to enter a transceiver’s operating frequency? **The keypad or VFO knob**

Explanation: Use the keypad or VFO knob on most modern transceivers to enter the operating frequency desired. This can vary depending on the model of radio you are using.

T4B03 - How is squelch adjusted so that a weak FM signal can be heard? **Set the squelch threshold so that receiver output audio is on all the time**

Explanation: In order to hear weak-signal FM stations, adjust the squelch so that the receiver's output audio is on all the time, in essence, you hear static even when the other station isn't transmitting.

T4B04 - What is a way to enable quick access to a favorite frequency or channel on your transceiver? **Store it in a memory channel**

Explanation: After you operate on the air for a while, you will develop a small list of your favorite frequencies. These favorite frequencies may be local repeaters in your area, important amateur radio nets or frequencies used for emergency communications. By storing these frequencies into your transceiver's memory channels, you will have quick access. Some transceivers give you the ability to scan your memory channels, too.

T4B05 - What does the scanning function of an FM transceiver do? **Tunes through a range of frequencies to check for activity**

Explanation: The scanning function on an FM transceiver will tune through a range of predetermined frequencies to search for activity. This automatic function helps you find frequencies that are in use to reach out to other stations.

T4B06 - Which of the following controls could be used if the voice pitch of a single sideband signal returning to your CQ call seems too high or low? **The receiver RIT or clarifier**

Explanation: Many times when you are on a single-sideband (SSB) net, some of the other stations' voice pitch will be a little too high or low. Without changing your transmitter's frequency, you can adjust your RIT (receiver incremental tuning) control to adjust your receiver to the proper voice pitch.

T4B07 - What does a DMR "code plug" contain? **Access information for repeaters and talk groups**

Explanation: A DMR "code plug" contains access information for repeaters and talk groups. This information is programmed into the radio via software.

T4B08 - What is the advantage of having multiple receive bandwidth choices on a multimode transceiver? **Permits noise or interference reduction by selecting a bandwidth matching the mode**

Explanation: Today's multimode transceivers have multiple bandwidth choices or filters available to the amateur operator. These filters allow you to eliminate, or reduce, noise and interference. You will select the bandwidth option that matches the mode you are using. Narrow modes such as CW allow you to use a narrow bandwidth such as 250 Hz or 500 Hz.

Single-sideband bandwidth is limited to 3 kHz, but most stations do not use that much bandwidth so a 2.4-kHz filter is best for SSB. Digital modes such as FT8 pack as many different signals as possible into a 3-kHz bandwidth. In this case, your 3-kHz or 3.5-kHz bandwidth option would be the best selection.

T4B09 - How is a specific group of stations selected on a digital voice transceiver? **By entering the group's identification code**

Explanation: To select a group on a digital voice transceiver, simply enter the group's identification code.

T4B10 - Which of the following receiver filter bandwidths provides the best signal-to noise ratio for SSB reception? **2400 Hz**

Explanation: When using SSB, choosing the 2400-Hz bandwidth option would be the appropriate option for the best signal-to-noise ratio for SSB reception.

T4B11 - Which of the following must be programmed into a D-STAR digital transceiver before transmitting? **Your call sign**

Explanation: Your call sign must be programmed into a D-STAR-capable radio before it can be used for transmitting in the digital mode. D-STAR requires a one-time online registration of your call sign before use.

T4B12 - What is the result of tuning an FM receiver above or below a signal's frequency? **Distortion of the signal's audio**

Explanation: You will hear distortion of the signal's audio if you tune an FM receiver above or below a signal's actual frequency.

T5 – Electrical Principles

T5A01 - Electrical current is measured in which of the following units? **Amperes**

Explanation: Electric current is measured in amperes, or amps. An ampere is the rate of flow of electrons. The flow rate of one coulomb per second is equal to one amp of current. You measure current flow with an amp meter connected in series with the electrical circuit. Many times you will see electrical current referenced as "A." **T5A02** - Electrical power is measured in which of the following units? **Watts**

Explanation: Electrical power is measured in watts, or sometimes kilowatts. (1 kilowatt is equal to 1,000 watts). A single watt is defined as the electrical power equal to one ampere at one volt. In Ohm's Law, Power = Amps times Volts.

T5A03 - What is the name for the flow of electrons in an electric circuit? **Current**

Explanation: The flow of electrons in an electrical circuit defines current. Current or amps is the rate of flow of electrons in an electrical circuit.

T5A04 - What are the units of electrical resistance? **Ohms**

Explanation: Ohms are the units of electrical resistance in the International System of Units. They can be measured using a multimeter or calculated using the Ohm's Law formula: Ohms = Voltage / Amps. The symbol for the ohm is Ω.

T5A05 - What is the electrical term for the force that causes electron flow? **Voltage**

Explanation: Volts is the definition for EMF (electromotive force) that causes electrons to flow. Volts sometimes is expressed as E (electromotive force).

T5A06 - What is the unit of frequency? **Hertz**

Explanation: Hertz are the units of frequency in the International System of Units, and in amateur radio are used to describe electromagnetic radiation. They can be measured using tools that count frequency, including an oscilloscope. The symbol for Hertz is Hz.

T5A07 - Why are metals generally good conductors of electricity? **They have many free electrons**

Explanation: Electrons are the primary part of an atom that conducts electricity. The chemical makeup of metal atoms allows electrons to move more freely than other types of material, this makes metal good conductors.

T5A08 - Which of the following is a good electrical insulator? **Glass**

Explanation: Glass is a good example of an electrical insulator. Glass is used on many high-voltage power distribution systems. Copper is an example of a good conductor.

T5A09 - Which of the following describes alternating current? **Current that alternates between positive and negative directions**

Explanation: Alternating current reverses the direction of the current flow regularly, so it "alternates" between positive and negative directions. The period that it takes to alternate in a

complete cycle is called the frequency. A radio signal is a type of electromagnetic alternating current and has a frequency.

T5A10 - Which term describes the rate at which electrical energy is used? **Power**

Explanation: Power is calculated as electromotive force times electrical current: Amps times Volts equals Watts.

T5A11 - What type of current flow is opposed by resistance? **All these choices are correct**

Explanation: Resistance is the opposition to current flow. Resistance is in Alternating Current fields, including Radio Frequency current, is called inductive resistance or inductance. In Direct Current fields it's called resistance. Both are measured in Ohms.

T5A12 - What describes the number of times per second that an alternating current makes a complete cycle? **Frequency**

Explanation: Frequency is defined as the number of times per second an alternating current completes a full cycle. Frequency is measured in cycles per second or Hz (Hertz). One CPS (cycle per second) = 1 Hz.

T5B01 - How many milliamperes is 1.5 amperes? **1500 milliamperes**

Explanation: 1,000 milliamps = 1 ampere. 1.5 amperes = 1500 milliamperes.

T5B02 - Which is equal to 1,500,000 hertz? - **1500 kHz**

Explanation: 1,000,000 Hz = 1 MHz or 1,000 kHz. 1,500,000 Hz = 1.5 MHz or 1500 kHz

T5B03 - Which is equal to one kilovolt? **One thousand volts** Explanation: 1,000

volts = 1 kilovolt.

T5B04 - Which is equal to one microvolt? **One one-millionth of a volt**

Explanation: 1 millionth of a volt = 1 microvolt

T5B05 - Which is equal to 500 milliwatts? **0.5 watts**

Explanation: 1 watt = 1000 milliwatts. Thus, 1/2 (0.5) watt = 500 milliwatts.

T5B06 - Which is equal to 3000 milliamperes? **3 amperes**

Explanation: 1 ampere = 1000 milliamperes. 3 amperes = 3000 milliamperes.

T5B07 - Which is equal to 3.525 MHz? **3525 kHz**

Explanation: 1 MHz = 1000 kHz. Thus 3.525 MHz = 3525 kHz.

T5B08 - Which is equal to 1,000,000 picofarads? **1 microfarad**

Explanation: 1 farad = 1,000,000,000 microfarads. 1 microfarad = 1,000,000 picofarads.

T5B09 - Which decibel value most closely represents a power increase from 5 watts to 10 watts? **3 dB**

Explanation: When working with decibels, every 3 dB of gain multiplies your signal by 2. Every 3 dB of loss divides your signal by 2. Thus, going from 5 watts to 10 watts is 3 dB of gain. And going from 10 watts to 5 watts is 3 dB of loss.

T5B10 - Which decibel value most closely represents a power decrease from 12 watts to 3 watts? **-6 dB**

Explanation: When working with decibels, every 6 dB of gain multiplies your signal by 4. Every 6 dB of loss divides your signal by 4. Thus, going from 12 watts to 3 watts is 6 dB of loss. Also, going from 10 watts to 40 watts is 6 dB of gain. Going from 40 watts to 10 watts is 6 dB of loss.

T5B11 - Which decibel value represents a power increase from 20 watts to 200 watts? **10 dB**

Explanation: When working with decibels, every 10 dB of gain multiplies your signal by 10. Every 10 dB of loss divides your signal by 10. Thus, going from 20 watts to 200 watts is 10 dB of gain. And going from 200 watts to 20 watts is 10 dB of loss.

T5B12 - Which is equal to 28400 kHz? **28.400 MHz**

Explanation: 1000 kHz = 1 MHz. 28400 kHz = 28.400 MHz.

T5B13 - Which is equal to 2425 MHz? **2.425 GHz**

Explanation: 1000 MHz = 1 GHz. 2425 MHz = 2.425 GHz.

T5C01 - What is the ability to store energy in an electric field called? **Capacitance**

Explanation: When the capacitor is discharged, the potential energy stored in the electric field is converted to the charge.

T5C02 - What is the unit of capacitance? **The farad**

Explanation: The unit of capacitance is the farad and describes the ability of an item to store electrical charge. Named after famous English physicist, Michael Faraday. **T5C03** - What is the ability to store energy in a magnetic field called? **Inductance**

Explanation: The ability to store energy in a magnetic field is inductance. A magnetic field is created by inductance.

T5C04 - What is the unit of inductance? **The henry**

Explanation: The basic unit of inductance is the henry. Inductors come in many different forms. The very basic inductor consists of a core with wire wrapped around it to produce a magnetic field.

T5C05 - What is the unit of impedance? **The ohm**

Explanation: Inductance is the resistance in an AC circuit. Ohms are the units of electrical resistance in the International System of Units. The symbol for the ohm is Ω.

T5C06 - What does the abbreviation "RF" mean? **Radio frequency signals of all types**

Explanation: The abbreviation for radio frequency is RF. This is the electromagnetic energy.

T5C07 - What is the abbreviation for megahertz? **MHz**

Explanation: In the International System of Units, MHz is the abbreviation for megahertz. The base unit Hertz is Hz. When units are at or above the megahertz range, the first letter is capitalized to indicate a high multiple and differentiate from lower units. For instance, kHz is kilohertz.

T5C08 - What is the formula used to calculate electrical power (P) in a DC circuit? **P = I x E**

Explanation: Ohm's Law provides the amateur operator with many useful formulas. You will use many of these formulas frequently during your time as an amateur radio operator. Calculating power is one of those basic formulas. P (power) = E (voltage) multiplied by I (current). This sometimes is referred to as amps x volts = watts.

T5C09 - How much power is delivered by a voltage of 13.8 volts DC and a current of 10 amperes? **138 watts**

Explanation: Here are the key pieces of information we need to solve this problem. How much power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes? They are looking for power, you are given 13.8 Volts DC, and you are given 10 amperes. Looking at Ohm's Law, we quickly see that amp's times volts equals power. Thus, 13.8 volts multiplied by 10 amperes equals 138 watts, or 13.8 x 10 = 138.

T5C10 - How much power is delivered by a voltage of 12 volts DC and a current of 2.5 amperes? **30 watts**

Explanation: These are the key pieces of information needed to solve this problem. How much power is being used in a circuit when the applied voltage is 12 volts DC and the current is 2.5 amperes? They are looking for power, you are given 12 volts DC and you are given 2.5 amperes. Looking at Ohm's Law, we quickly see that amp's times volts equals power. Thus, 12 volts multiplied by 2.5 amperes equals 30 watts, or 12 x 2.5 = 30.

T5C11 - How much current is required to deliver 120 watts at a voltage of 12 volts DC? **10 amperes**

Explanation: Let's use the key pieces of information to solve this. How many amperes are flowing in a circuit when the applied voltage is 12 volts DC and the load is 12 watts? They are asking for amperes; you are given 12 volts DC and you are given 120 watts. Looking at the power formula, we quickly see that watts/volts equals amperes. Thus, 120 watts divided by 12 volts equals 10 amperes, or 120/12 = 10

T5C12 - What is impedance? **The opposition to AC current flow**

Explanation: Impedance is a unit of measure of the opposition to AC current flow in a circuit. In a DC circuit, the opposition of flow would be called resistance.

T5C13 - What is the abbreviation for kilohertz? **kHz**

Explanation: In the International System of Units, kHz is the abbreviation for kilohertz. The base unit Hertz is Hz. When units are at or below above the kilohertz range, the first letter is lowercase to indicate a lower multiple and differentiate from higher units. For instance MHz would be megahertz.

T5D01 - What formula is used to calculate current in a circuit? **I = E / R**

Explanation: Using Ohm's Law, I (current) equals E (voltage) divided by R (resistance), or I = E / R.

T5D02 - What formula is used to calculate voltage in a circuit? **E = I x R**

Explanation: Using Ohm's Law, E (voltage) equals I (current) multiplied by R (resistance), or E = I x R.

T5D03 - What formula is used to calculate resistance in a circuit? **R = E / I**

Explanation: Using Ohm's Law, R (resistance) equals E (voltage) divided by I (current), or R = E / I.

T5D04 - What is the resistance of a circuit in which a current of 3 amperes flows when connected to 90 volts? **30 ohms**

Explanation: Using the key pieces of information we need to solve this problem, what is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts? They are looking for R (resistance), you are given I (current) of 3 amperes and you are given E, which is 90 volts. Looking at Ohm's Law, we quickly see that volts divided by amperes equals resistance, or R = E / I. Thus, 90 volts divided by 3 amperes equals 30 ohms, or 90 / 3 = 30.

T5D05 - What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes? **8 ohms**

Explanation: Using the key pieces of information we need to solve this problem, what is the resistance in a circuit in which the applied voltage is 12 volts and the current flow is 1.5 amperes? They are looking for R (resistance), you are given E, which is 12 volts, and you are given I (current) which is 1.5 amperes. Using Ohm's Law, we quickly see that volts divided by amperes equals resistance, or R = E / I. Thus, 12 volts divided by 1.5 amperes equals 8 ohms, or 12 / 1.5 = 8.

T5D06 - What is the resistance of a circuit that draws 4 amperes from a 12-volt source? **3 ohms**

Explanation: Using the key pieces of information we need to solve this problem, what is the resistance of a circuit that draws 4 amperes from a 12-volt source? They are looking for R (resistance), you are given I (current) of 4 amperes and you are given E, which is 12 volts. Looking at Ohm's Law, we quickly see that volts divided by amperes gives resistance, or R = E / I. 12 volts divided by amperes equals resistance, or R = E / I. Thus, 12 volts divided by 4 amperes equals 3 ohms, or 12 / 4 = 3.

T5D07 - What is the current in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms? **1.5 amperes**

Explanation: Using the key pieces of information we need to solve this problem, what is the current in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms? They are looking for I (current), you are given E, which is 120 volts, and you are given R, which is 80 ohms. Looking at Ohm's Law we quickly see that volts divided by resistance equals current, or I = E / R. Thus, 120 volts divided by 80 ohms equals 1.5 amperes, or 120 / 80 = 1.5.

T5D08 - What is the current through a 100-ohm resistor connected across 200 volts? **2 amperes**

Explanation: Using the key pieces of information we need to solve this problem, what is the current through a 100-ohm resistor connected across 200 volts? They are looking for I (current), you are given R (resistance) of 100 ohms and you are given E, which is 200 volts. Looking at Ohm's Law we quickly see that volts divided by resistance equals current, or I = E / R. Thus, 200 volts divided by 100 ohms equals 2 amperes, or 200 / 100 = 2.

T5D09 - What is the current through a 24-ohm resistor connected across 240 volts? **10 amperes**

Explanation: Using the key pieces of information we need to solve this problem, what is the current through a 24-ohm resistor connected across 240 volts? They are looking for I (current), you are given R (resistance) of 24 ohms and you are given E, which is 240 volts. Looking at Ohm's Law, we quickly see that volts divided by resistance equals current, or I = E / R. Thus, 240 volts divided by 24 ohms equals 10 amperes, or 240 / 24 = 10.

T5D10 - What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it? **1 volt**

Explanation: Using the key pieces of information we need to solve this problem, what is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it? They are looking for E (volts), you are given R (resistance) of 2 ohms and you are given I (current) which is 0.5 amperes. Looking at Ohm's Law, we quickly see that amperes multiplied by resistance equals voltage, or E = I x R. Thus, 2 ohms multiplied by 0.5 amperes equals 1 volt, or 2 x 0.5 = 1.

T5D11 - What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it? **10 volts**

Explanation: Using the key pieces of information we need to solve the problem, what is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it? They are looking for E (volts), you are given R (resistance) of 10 ohms and you are given I (current) of 1 amperes. Looking at Ohm's Law, we quickly see that amperes multiplied by ohms equals volts, or E = I x R. Thus, 10 ohms multiplied by 1 ampere equals 10 volts, or 10 x 1 = 10.

T5D12 - What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it? **20 volts**

Explanation: Using the key pieces of information we need to solve the problem, what is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it? They are looking for E (volts), you are given R (resistance) of 10 ohms and you are given I (current) of 2 amperes. Looking at Ohm's Law, we quickly see that amperes multiplied by ohms equals volts, or E = I x R. Thus, 10 ohms multiplied by 2 amperes equals 20 volts, or 10 x 2 = 20.

T5D13 - In which type of circuit is DC current the same through all components? **Series**

Explanation: A series circuit only has one path for the current to flow, so DC current is the same through all the components, however voltage may drop. A parallel circuit has sections so the current divides when flowing through the different areas.

T5D14 - In which type of circuit is voltage the same across all components? **Parallel**

Explanation: A parallel circuit has voltage equal across all components, but current may be different in different sections. A series circuit only has one path for the current to follow through so the current is the same through all the components, however voltage may drop.

T6 – Electrical Components

T6A01 - What electrical component opposes the flow of current in a DC circuit? **Resistor**

Explanation: A resistor opposes the flow of current in a DC circuit. The unit of measure for a resistor is an ohm.

T6A02 - What type of component is often used as an adjustable volume control? **Potentiometer**

Explanation: The electronic component used as an adjustable volume control is a variable resistor commonly known as a potentiometer. A potentiometer sometimes is referred to as a "pot." Pots come in several different flavors: linear function, log function and audio function, as far as their relationship to resistance to the amount the knob is turned.

T6A03 - What electrical parameter is controlled by a potentiometer? **Resistance**

Explanation: A potentiometer is a variable resistor. A potentiometer has three electrical connections. If all three connections are used in the circuit, the device still is called a potentiometer, but if only two connections are used, the device is called a rheostat. A potentiometer's unit of measure is in ohms.

T6A04 - What electrical component stores energy in an electric field? **Capacitor**

Explanation: When working on electronic equipment that has been unplugged and disconnected, a shock hazard still exists. Capacitors have the ability to store electricity for periods of time.

T6A05 - What type of electrical component consists of conductive surfaces separated by an insulator? **Capacitor**

Explanation: A capacitor stores electrical energy in an electrical circuit. The conductive surfaces of a capacitor may be foil, film or metal separated by glass, ceramic, air or other elements that provide insulation.

T6A06 - What type of electrical component stores energy in a magnetic field? **Inductor**

Explanation: An inductor stores energy in a magnetic field when current flows through it. Inductors are also called chokes or coils. Generally, the more turns of a coil, the higher the inductance.

T6A07 - What electrical component is typically constructed as a coil of wire? **Inductor**

Explanation: An inductor is composed of a coil of wire. Sometimes you will see the coil constructed from small copper tubing. Remember the "skin effect." In AC circuits, the current flows on the outside of the conductor.

T6A08 - What is the function of an SPDT switch? **A single circuit is switched between one of two other circuits**

Explanation: SPDT stands for single pole, double throw. It is a switch that has a single input and two outputs. You might see this as a “low / high” switch in a circuit.

T6A09 - What electrical component is used to protect other circuit components from current overloads? **Fuse**

Explanation: A fuse is the most common electrical component used to protect other circuit components from current overloads or fault conditions. A fuse is engineered to carry only the current that is marked on the rating. If you exceed the designated current, the link will melt and the fuse will create the open circuit condition.

T6A10 - Which of the following battery chemistries is rechargeable? **All of these choices are correct**

Explanation: The most common types of rechargeable batteries are lead-acid, nickel metal hydride (NiMH) and lithium-ion (Li-ion). Older handheld amateur radios still use the original nickel-cadmium (NiCd).

T6A11 - Which of the following battery chemistries is not rechargeable? **Carbon-zinc**

Explanation: Carbon-zinc batteries are not rechargeable. The chemical reactions that produce the electricity are not reversible. Do not try to recharge carbon-zinc batteries as they may leak or could explode.

T6A12 - What type of switch is represented by component 3 in figure T-2? **Single pole single-throw**

Explanation: The schematic shows a single pole, single throw switch. This performs one function, to connect or disconnect this part of the circuit.

T6B01 - Which is true about forward voltage drop in a diode? **It is lower in some diode types than in others**

Explanation: A diode is a part of a circuit that allows a current to flow in only one direction. In the forward direction, a minimum amount of voltage, called the voltage drop, is required to have the diode conduct current. Because different materials are used in diodes, voltage drop is lower in some diode types.

T6B02 - What electronic component allows current to flow in only one direction? **Diode**

Explanation: The diode is classified as a semiconductor. The diode allows current to flow in only one direction. A diode is most commonly found in power supply circuits performing as a rectifier.

T6B03 - Which of these components can be used as an electronic switch? **Transistor**

Explanation: A transistor is classified as a semiconductor device. The transistor is commonly used as an amplifier or as a switch to control electric signals and power.

T6B04 - Which of the following components can consist of three layers of semiconductor material? **Transistor**

Explanation: The transistor is composed of three layers of semiconductor material and is doped with N and P dopants. The N-type dopants donate electrons, while the P-type dopants accept electrons. These configurations allow for two types of transistor configurations, the NPN and the PNP types.

T6B05 - What type of transistor has a gate, drain, and source? **Field-effect**

Explanation: A field effect transistor controls the current in a semiconductor via an electric field. The gate is used to control the current passing between the source and the drain. It is a unipolar transistor.

T6B06 - How is the cathode lead of a semiconductor diode often marked on the package? **With a stripe**

Explanation: The cathode lead of a semiconductor diode often is marked on the package with a stripe closest to the lead.

T6B07 - What causes a light-emitting diode (LED) to emit light? **Forward current**

Explanation: LED stands for light-emitting diode. Using LEDs for light sources is much more efficient than using incandescent light bulbs. LEDs are known for their low current consumption and low heat generation.

T6B08 - What does the abbreviation FET stand for? **Field Effect Transistor**

Explanation: FET stands for field-effect transistor. This type of transistor uses an electric field to control the flow of current. FETs are commonly found in amateur radio receivers because of their efficiency in the RF ranges.

T6B09 - What are the names for the electrodes of a diode? **Anode and cathode** Explanation:

Current flows into the anode and out of the cathode.

T6B10 - Which of the following can provide power gain? **Transistor**

Explanation: The transistor is the primary gain-producing component in an RF power amplifier. Understanding the function of each component in the list, you will see that the transistor is the only component that produces gain.

T6B11 - What is the term that describes a device's ability to amplify a signal? **Gain**

Explanation: Gain is the term that commonly describes a device's ability to amplify a signal. The gain or loss are expressed in units of dB.

T6B12 - What are the names of the electrodes of a bipolar junction transistor? **Emitter, base, collector**

Explanation: A bipolar junction transistor allows a small current at one terminal to control larger current at its other terminals allowing for amplification or switching. The energy passing from the collector to emitter is controlled by the base.

T6C01 - What is the name of an electrical wiring diagram that uses standard component symbols? **Schematic**

Explanation: The schematic or schematic diagram is the name of an electrical wiring diagram that uses standard component symbols.

T6C02 - What is component 1 in figure T1? **Resistor**

Explanation: Electronic component 1 in figure T1 is a resistor. This resistor is in series with the

connector and the base of transistor 2. **T6C03** - What is component 2 in figure T1? **Transistor**

Explanation: This is an NPN transistor.

T6C04 - What is component 3 in figure T1? **Lamp**

Explanation: Electronic component 3 in figure T1 is a lamp. One lead of the lamp goes to the collector of the transistor (component 2) and the other lead goes to the "+" (plus) terminal on the battery.

T6C05 - What is component 4 in figure T1? **Battery**

Explanation: Electronic component 4 in figure T1 is a battery. The "+" (positive) lead of the battery goes to one lead of the lamp (component 3) and the "-" (negative) lead of the battery goes to ground.

T6C06 - What is component 6 in figure T2? **Capacitor**

Explanation: Electronic component 6 in figure T2 is a capacitor. One lead of the capacitor goes to ground; the other lead goes to power bus.

T6C07 - What is component 8 in figure T2? **Light emitting diode**

Explanation: Note the straight line on the LED symbol; this is the cathode side of the component.

T6C08 - What is component 9 in figure T2? **Variable resistor**

Explanation: Electronic component 9 in figure T2 is a variable resistor, or potentiometer.

T6C09 - What is component 4 in figure T2? **Transformer**

Explanation: Electronic component 4 in figure T2 is a transformer. Note the left-hand side of the transformer is the primary and the right hand side is the secondary winding.

T6C10 - What is component 3 in figure T3? **Variable inductor**

Explanation: Electronic component 3 in figure T3 is a variable inductor.

T6C11 - What is component 4 in figure T3? **Antenna**

Explanation: Electronic component 4 in figure T3 is an antenna.

T7 – Station Equipment

T7A01 - Which term describes the ability of a receiver to detect the presence of a signal? **Sensitivity**

Explanation: Sensitivity is the ability of a receiver to detect the presence of a signal. Sensitivity is a measure of a receiver's performance; the values usually are expressed in microvolts. Understanding these performance indicators is important when making comparisons between different pieces of radio equipment. Calibrated signal generators can easily help you make or confirm a receiver's sensitivity with little or no effort.

T7A02 - What is a transceiver? **A device that combines a receiver and transmitter**

Explanation: A transceiver is a single unit that combines a transmitter and a receiver. Many older pieces of amateur radio equipment consisted of separate transmitter and receiver units.

T7A03 - Which of the following is used to convert a signal from one frequency to another? **Mixer**

Explanation: The mixer circuit is used to convert a radio signal from one frequency to another. When two RF signals are mixed together you will get two additional frequencies. One will be the sum of the two frequencies and the other will be the difference of the two signals. So if you mix together a 5-MHz frequency and a 3-MHz frequency, you will get an 8-MHz frequency and a 2-MHz frequency. 5 MHz + 3 MHz = 8 MHz (sum) and 5 MHz - 3 MHz = 2 MHz (difference).

T7A04 - Which term describes the ability of a receiver to discriminate between multiple signals? **Selectivity**

Explanation: Selectivity is the ability of a receiver to discriminate between multiple signals. Selectivity is another important property of a receiver. The selectivity of a receiver measures its ability to allow you to receive your desired signals when other stronger stations are on adjacent frequencies. This is another important performance indicator to consider when purchasing amateur radio equipment.

T7A05 - What is the name of a circuit that generates a signal at a specific frequency? **Oscillator**

Explanation: An oscillator circuit generates a signal at a specific frequency. There are many different types of oscillators that are used in radio circuits; the Pierce and crystal oscillator circuits are just two examples. Some modern amateur transmitters still offer high-stability crystal oscillators as an added accessory option.

T7A06 - What device converts the RF input and output of a transceiver to another band? **Transverter**

Explanation: A common use of a transverter is to allow amateur stations to easily get on the VHF and UHF bands without the investment of new radios specifically for VHF and UHF. Most amateur radio stations have a multimode transceiver with nice filters and many operating features. An inexpensive transverter will typically take your transceiver's 10-meter output and convert to 2 meters or 70 centimeters, then receive the same frequencies and convert them back to 10 meters. This allows you to utilize expensive radio equipment you already own.

T7A07 - What is the function of a transceiver's PTT input? **Switches transceiver from receive to transmit when grounded**

Explanation: PTT is an abbreviation for Push To Talk. So activating the transceivers PTT input turns on the transmitter part of the radio.

T7A08 - Which of the following describes combining speech with an RF carrier signal? **Modulation**

Explanation: Modulation is the combining of speech with an RF carrier signal. There are two basic types of modulation: amplitude modulation (AM) and frequency modulation (FM). Amplitude modulation varies the signal's power with respect to the modulation characteristics of your voice pattern. Frequency modulation varies the frequency of the carrier based on the modulation characteristics of your voice pattern.

T7A09 - What is the function of the SSB/CW-FM switch on a VHF power amplifier? **Set the amplifier for proper operation in the selected mode**

Explanation: Most VHF power amplifiers are multimode. This means they can operate SSB, CW and FM. The VHF power amplifier will have an SSB and CW-FM selector switch to set the amplifier for the proper operation of the mode you wish to use. Running an SSB-modulated signal into a VHF amplifier set to FM will result in a distorted signal and could damage the VHF amplifier.

T7A10 - What device increases the transmitted output power from a transceiver? **An RF power amplifier**

Explanation: An RF (radio frequency) amplifier increases the low-power output from a handheld transceiver to a higher power level. This type of RF amplifier usually takes the 1-watt to 5-watt signal and amplifies it to 25 watts to 50 or more watts. Perform a cost analysis because sometimes it is just cheaper to purchase a mobile radio to use in place of the handheld transceiver.

T7A11 - Where is an RF preamplifier installed? **Between the antenna and receiver**

Explanation: An RF preamplifier amplifies the received signal when working with weak-signal reception. The RF preamplifier goes between the receiver and the antenna; the closer it is placed to the antenna will provide the best performance. If you install the RF preamplifier close to the receiver, you will never recover the signals you lost because of feed line losses.

T7B01 - What can you do if you are told your FM handheld or mobile transceiver is over-deviating? **Talk farther away from the microphone**

Explanation: Talking farther away from the microphone is an easy way to improve your signal when you are told your FM handheld or mobile transceiver is over deviating. This same technique also is effective when you are told you are chopping in and out of the repeater on voice peaks.

T7B02 - What would cause a broadcast AM or FM radio to receive an amateur radio transmission unintentionally? **The receiver is unable to reject strong signals outside the AM or FM band**

Explanation: A receiver that is unable to reject strong signals outside the AM or FM band would receive amateur radio transmissions unintentionally. If this is happening to you, you should verify all your equipment is working properly. Verify the SWR on your antenna is in the acceptable range and that you do not have any connections in the feed line or the antenna that have been compromised because of the elements.

T7B03 - Which of the following can cause radio frequency interference? **All of these choices are correct**

Explanation: Harmonics interference is when a multiple of your operating frequency falls within the frequency the other receiver is capable of tuning. Spurious emissions sometimes are caused by a misadjusted or misaligned transmitter.

T7B04 - Which of the following could you use to cure distorted audio caused by RF current on the shield of a microphone cable? **Ferrite choke**

Explanation: A ferrite choke, also known as a ferrite bead, dissipates high frequency current to help eliminate electromagnetic interference.

T7B05 How can fundamental overload of a non-amateur radio or TV receiver by an amateur signal be reduced or eliminated? **Block the amateur signal with a filter at the antenna input of the affected receiver**

Explanation: In other words, the amateur can install a filter at the antenna of the non-amateur radio or TV receiver to eliminate or reduce fundamental overload.

T7B06 - Which of the following actions should you take if a neighbor tells you that your station's transmissions are interfering with their radio or TV reception? **Make sure that your station is functioning properly and that it does not cause interference to your own radio or television when it is tuned to the same channel**

Explanation: Making sure that your station is functioning properly and that it does not cause interference to your radio or television when it is tuned to the same channel is the first action you should take if a neighbor tells you that your station's transmissions are interfering with their radio or TV reception. If you do in fact have a problem, it will be much easier to solve in your own home than your neighbors. Once the problem is solved for your own radio and television, the problem will have been solved for your neighbor as well.

T7B07 - Which of the following can reduce overload of a VHF transceiver by a nearby commercial FM station? **Installing a band-reject filter**

Explanation: Also, you do not need an RF preamplifier in this case because the signal already is so strong it is overloading your transceiver's input.

T7B08 - What should you do if something in a neighbor's home is causing harmful interference to your amateur station? **All of these choices are correct**

Explanation: Sometime during your time as a licensed amateur radio operator, you will have a situation where something in a neighbor's home is causing harmful interference to your station. When this occurs, you should check your own station and make sure it meets the standards of good amateur radio practice. After you have verified the interference is originating from your neighbor's equipment, you should work with your neighbor to identify the offending device. Finally, politely inform your neighbor about the rules that prohibit the use of devices that cause interference. In all cases, be professional and courteous with all your neighbors.

T7B09 - What should be the first step to resolve non-fiber optic cable TV interference caused by your amateur radio transmission? **Be sure all TV feed line coaxial connectors are installed properly**

Explanation: A loose coaxial cable connection can expose the inner conductor (copper core) where most of the signals are carried. Tightening the cable allows the outer core to do its job as a shield.

T7B10 - What might be a problem if you receive a report that your audio signal through an FM repeater is distorted or unintelligible? **All of these choices are correct**

Explanation: There are several conditions that might cause you to receive reception reports that your audio signal through the repeater is distorted or unintelligible. The circumstances may be that you are in a bad location and your signal is not being received into the repeater. If this is the case, try moving your HT or vehicle a few feet and see whether the condition clears up. Be sure to check that your batteries are fully charged; low batteries can cause you to have a weak signal and/or distorted audio. Finally, verify that you are transmitting on the proper frequency. Some VHF transceivers make it really easy to bump the frequency button up or down 5 kHz.

T7B11 - What is a symptom of RF feedback in a transmitter or transceiver? **Reports of garbled, distorted, or unintelligible voice transmissions**

Explanation: A transmission that is distorted, garbled or unintelligible is a symptom of RF feedback in a transmitter or transceiver. This condition is not all that uncommon. Sometimes reducing your power or trying a different microphone is a quick and easy way to determine when your transmitter's signal is being picked up by your microphone or audio input circuits. If reducing your power cures your RF feedback, then you know RF is getting into your microphone or audio circuits.

T7C01 - What is the primary purpose of a dummy load? **To prevent transmitting signals over the air when making tests**

Explanation: The dummy load is very useful for troubleshooting.

T7C02 - Which of the following is used to determine if an antenna is resonant at the desired operating frequency? **An antenna analyzer**

Explanation: An antenna analyzer is an instrument that can be used to determine whether an antenna is resonant at the desired operating frequency. The antenna analyzer puts out a tiny signal just like your own transmitter, except the antenna analyzer can determine the reactance, impedance, standing wave ratio and resonant frequency of the antenna being evaluated, and in some cases it can detect a cable fault in your feed line.

T7C03 - What does a dummy load consist of? **A non-inductive resistor mounted on a heat sink**

Explanation: A dummy load takes the place of an antenna to allow a transmitter to be tested without sending signals over the air. The heat sink is used to dissipate the power of the transmitter during the test.

T7C04 What reading on an SWR meter indicates a perfect impedance match between the antenna and the feed line? **1 to 1**

Explanation: A 1 to 1 reading on an SWR meter indicates a perfect impedance match between the antenna and the feed line. The 1 to 1 reading would be expressed as 1:1. Some amateur radio transmitters will fail to transmit and give an antenna fault if the SWR is over 2:1. Other transmitters will automatically reduce the power output until the SWR moves into an acceptable range.

T7C05 - Why do most solid-state transmitters reduce output power as SWR increases beyond a certain level? **To protect the output amplifier transistors**

Explanation: The most important part of an amateur radio transmitter circuit is the output amplifier transistors. In some cases, the most expensive part of the transmitter are the amplifier transistors. Most solid-state transmitters reduce output power as SWR increases in order to protect the output amplifier transistors. A common name for the circuit that reduces power in the presence of high SWR is a "foldback circuit."

T7C06 - What does an SWR reading of 4:1 indicate? **Impedance mismatch**

Explanation: An SWR (standing wave ratio) reading of 4:1 indicates an impedance mismatch. Given a transmitter putting out 100 watts, 36 of those watts would be reflected back into the transmitter with an SWR of 4:1. A best practice is to keep your SWR below 1.5:1.

T7C07 - What happens to power lost in a feed line? **It is converted into heat**

Explanation: The power lost in a feed line is converted to heat. Energy is never lost, it always is converted from one type to another. So if your transmitter puts out 100 watts but only 50 watts is measured at the antenna, your feed line is absorbing the 50 watts and that power is lost forever. This energy is dissipated in your feed line as heat.

T7C08 - Which instrument can be used to determine SWR? **Directional wattmeter**

Explanation: The directional watt meter can measure the forward and reflected power in watts. The directional watt meter gives you reflected power in actual watts instead of a ratio. Most all directional wattmeter's come with a chart with three columns. The left-hand column has the forward power, the middle scale has the SWR values and the right-hand column has the reflected power. You just put a straight edge from the forward power to the reflected power and the values in the middle column that cross the straight edge are the actual SWR readings.

T7C09 - Which of the following causes failure of coaxial cables? **Moisture contamination**

Explanation: Moisture in a coaxial cable can cause corrosion in the shield or degradation of the dielectric element. Either will cause additional resistance and lower power through the cable.

T7C10 - Why should the outer jacket of coaxial cable be resistant to ultraviolet light?
Ultraviolet light can damage the jacket and allow water to enter the cable

Explanation: The outer jacket of coaxial cable should be resistant to ultraviolet light, otherwise UV can damage the jacket and allow water to enter the cable.

T7C11 - What is a disadvantage of air core coaxial cable when compared to foam or solid dielectric types? **It requires special techniques to prevent moisture in the cable**

Explanation: One disadvantage of air core coaxial cable when compared to foam or solid dielectric types is that it requires special techniques to prevent water absorption. Some air core coaxial cables are charged with an inert gas to keep out moisture. Some air core coaxial cable has limitations on how tight of a radius they can be bent or folded.

T7D01 - Which instrument would you use to measure electric potential? **A voltmeter**

Explanation: You would use a voltmeter to measure electric potential or electromotive force. Remember E (electromotive force) is measured in volts.
Remember: think safety. Always use caution when taking readings in a live circuit.

T7D02 - How is a voltmeter connected to a component to measure applied voltage?
In parallel

Explanation: The correct way to connect a voltmeter to a circuit is in parallel. This configuration will measure the voltage across the circuit. Always start on a higher scan and slowly work down. Remember: safety first when measuring values in energized circuits.

T7D03 - When configured to measure current, how is a multimeter connected to a component? **In series**

Explanation: Current is measured in series in a circuit. This allows the current to flow through the ammeter or multimeter to be measured. Ensure the probes used can support the amount of amperage in the circuit.

T7D04 - Which instrument is used to measure electric current? **An ammeter**

Explanation: An ammeter is an instrument used to measure electric current.
Remember: I (electric current) is measured in amperes.

T7D06 Which of the following can damage a multimeter? **Attempting to measure voltage when using the resistance setting**

Explanation: Inattention to detail or being in a hurry can easily and quickly damage sensitive test equipment. Please pay attention and be safe when making any measurements on an energized circuit.

T7D07 - Which of the following measurements are made using a multimeter? **Voltage and resistance**

Explanation: Multimeters have a minimum of two modes, one that measures voltage and one that measures resistance. More advanced meters may measure other items, but this question is focused on the basics.

T7D08 - Which of the following types of solder should not be used for radio and electronic applications? **Acid-core solder**

Explanation: Solder is used to join electrical connections and contains elements like tin and lead. Rosin core solder is typically used in electronics because it contains an element, rosin flux, that cleans the contact as the solder is heated. Acid core solder is more aggressive and made for steel and other metals.

T7D09 - What is the characteristic appearance of a cold tin-lead solder joint? **A rough or lumpy surface**

Explanation: There are many YouTube videos on proper soldering techniques. Each type of solder material has its own unique look and when using cold tin-lead, it has a rough finish when the soldering is complete.

T7D10 - What reading indicates that an ohmmeter is connected across a large, discharged capacitor? **Increasing resistance with time**

Explanation: In order to measure resistance of a circuit, an ohmmeter uses a small electrical charge. If a large, discharged capacitor is in the circuit being measured, the capacitor will want to store the charge and this will look like increasing resistance to the ohmmeter.

T7D11 - Which of the following precautions should be taken when measuring in circuit resistance with an ohmmeter? **Ensure that the circuit is not powered**

Explanation: This is for both personal safety and the safety of your test equipment. When taking measurements using test equipment, always devote your full attention to what you are doing.

T8 – Modulation Modes

T8A01 - Which of the following is a form of amplitude modulation? **Single sideband**

Explanation: SSB (single sideband) is one form of amplitude modulation. Simply put, the louder your voice the more the amplitude of the carrier. Of all the different variations of amplitude modulation, SSB is the most common voice mode on amateur radio HF bands.

T8A02 - What type of modulation is commonly used for VHF packet radio transmissions? **FM or PM**

Explanation: FM (frequency modulation) is most commonly used for VHF packet radio transmissions. Many older FM transceivers without subaudible tone capabilities have found their way into ham radio packet communications. A packet repeater is called a digipeater.

T8A03 - Which type of voice mode is most often used for long-distance (weak signal) contacts on the VHF and UHF bands? **SSB**

Explanation: SSB (single sideband) voice mode is most often used for long-distance (weak signal) contacts on the VHF and UHF bands. There are several VHF and UHF contests where nearly all voice contacts are made via SSB, while other contacts are made using CW. Horizontally polarized antennas are most commonly used for SSB communications on VHF and UHF amateur frequencies.

T8A04 - Which type of modulation is commonly used for VHF and UHF voice repeaters? **FM or PM**

Explanation: FM (frequency modulation) is most commonly used for VHF and UHF voice repeaters. Almost all VHF and UHF FM repeaters use vertical polarization.

T8A05 - Which of the following types of signal has the narrowest bandwidth? **CW**

Explanation: CW (continuous wave) or Morse code emissions have the narrowest bandwidth. CW transmissions normally use only about 25 Hz of bandwidth, depending on the speed of the transmission. On VHF and UHF amateur bands, FM typically uses about 10 kHz of bandwidth for voice transmission. SSB and SSTV normally use about 3 kHz of bandwidth for a typical signal. From the list of given modes, CW has the narrowest bandwidth.

T8A06 Which sideband is normally used for 10 meter HF, VHF, and UHF single sideband communications? **Upper sideband**

Explanation: USB (upper sideband) normally is used for 10-meter, HF, VHF and UHF single-sideband communications. In amateur radio, it is a common practice that frequencies below 10 MHz use LSB (lower sideband). For frequencies 10 MHz and above, use USB (upper sideband).

T8A07 - What is a characteristic of single sideband (SSB) compared to FM? **SSB signals have narrower bandwidth**

Explanation: SSB (single sideband) emissions only use 3 kHz of bandwidth while FM voice transmissions use 10 kHz to 15 kHz of bandwidth. This narrow bandwidth is an advantage of SSB over FM for voice transmissions.

T8A08 - What is the approximate bandwidth of a typical single sideband (SSB) voice signal? **3 kHz**

Explanation: 3 kHz is the approximate bandwidth of an SSB (single sideband) voice signal. Most modern amateur transceivers today limit the audio bandwidth frequencies on SSB. The transmitter's audio circuits limit audio frequencies below 300 Hz. So 3 kHz - 300 Hz = 2.7 kHz bandwidth. Most SSB receive filters are for a bandwidth of 2.4 kHz.

T8A09 - What is the approximate bandwidth of a VHF repeater FM phone signal? **Between 10 and 15 kHz**

Explanation: Between 10 kHz and 15 kHz is the approximate bandwidth of a VHF repeater FM phone signal. VHF and UHF FM repeater communications still remains one of the most popular activities in amateur radio. The repeater extends the range of low-power handheld devices as well as low-powered mobile stations. Digital modes such as DMR (Digital Mobile Radio) utilize time slots so that two different stations may use the same frequency at the same time, just as long as they are on different time slots. DMR is an efficient use of our bandwidth. Repeaters that have battery backup power or solar power are very valuable for emergency communications.

T8A10 - What is the approximate bandwidth of AM fast-scan TV transmissions? **About 6 MHz**

Explanation: Because of the 6-MHz bandwidth required, the FCC only allows analog fast scan television on amateur bands 70 cm (432 MHz) and above.

T8A11 - What is the approximate bandwidth required to transmit a CW signal? **150 Hz.**

Explanations:
In case you have not noticed, many of the FCC's exam questions concern bandwidth.

T8A12 - Which of the following is a disadvantage of FM compared with single sideband? **Only one signal can be received at a time**

Explanation: FM or frequency modulated signals are typically “captured” by a receiver meaning only the strongest is shared through the circuitry. AM or amplitude modulation signals are demodulated differently allowing multiple signals to be heard at the same time. This is part of the reason why air traffic controller radios still use AM modulation, so multiple planes could be heard if pilots talked at the same time.

T8B01 - What telemetry information is typically transmitted by satellite beacons? **Health and status of the satellite**

Explanation: The health and status of the satellite is the telemetry information that is typically transmitted by satellite beacons. The owners and operators of amateur radio satellites use this telemetry data to make operational decisions that are in the best interest of the satellite. This information also can be traced and compared to previous health and status messages to determine whether any components are degrading or deteriorating in their ability to function at full capacity.

T8B02 - What is the impact of using excessive effective radiated power on a satellite uplink? **Blocking access by other users**

Explanation: It will be no secret as to who is running too much power and spoiling the fun for everyone else.

T8B03 - Which of the following are provided by satellite tracking programs? **All of these choices are correct**

Explanation: There are many key pieces of information that are provided by amateur satellite tracking programs and smartphone apps. Most all amateur satellite tracking programs give the user the apparent frequency of the satellite transmission, including effects of Doppler shift. The programs also provide an easy to-read display of the time, azimuth and elevation of the start, maximum altitude and end of the pass, all plotted on maps showing the real-time position of the satellite track over Earth.

T8B04 - What mode of transmission is commonly used by amateur radio satellites? **All of these choices are correct**.

Explanation: CW/data, FM and SSB are transmission modes that are commonly used by amateur satellites. Some of the amateur satellites that support data transmissions have a store-and-forward feature. You upload your digital message

via packet radio to the intended station. When the satellite is over the other station's location, they can download the message. Other modes, such as SSB, are real time where as you transmit your signal is being rebroadcast back to Earth from the satellite.

T8B05 - What is a satellite beacon? **A transmission from a satellite that contains status information**

Explanation: A transmission for an amateur radio satellite that contains status information is called a satellite beacon. The beacon signals from amateur satellites are used by operators all over the world for different applications. Some stations use the beacons to verify their antennas and equipment are working properly. Other stations listen for the beacons to ensure their satellite tracking software is configured properly. Satellite owners and operators use the health and telemetry contained in the beacon message to determine the satellite's operational schedule. Not to confuse the issue, but there also are fixed land-based beacon transmitters in use as well.

T8B06 - Which of the following are inputs to a satellite tracking program? **The Keplerian elements**

Explanation: Keplerian elements are used as inputs to a satellite tracking program. Keplerian elements are named after Johannes Kepler and his laws of planetary motion. The elements are a set of parameters about each orbiting object or satellite. The satellite tracking program uses this data to accurately plot and display the exact location of a given satellite based on your location on Earth and your local time.

T8B07 - What is Doppler shift in reference to satellite communications? **An observed change in signal frequency caused by relative motion between the satellite and the Earth station**

Explanation: Watch any old movie from the 1930s and 1940s that involves a train. As the train approaches the crossing, you will hear the ding, ding, ding crossing signal go up in frequency. As they pass the railroad crossing, the ding, ding, ding sound goes down in frequency. This is a perfect example of Doppler shift.

T8B08 - What is meant by the statement that a satellite is operating in U/V mode? **The satellite uplink is in the 70 centimeter band and the downlink is in the 2 meter band**

Explanation: Uplink refers to you transmitting to the satellite. Downlink refers to you receiving from the satellite.

T8B09 - What causes spin fading of satellite signals? **Rotation of the satellite and its antennas**

Explanations:
All amateur radio satellites in space are orbiting Earth. The satellites
are not stationary in space. Usually the satellites rotate in one direction or another as they are moving in space. Even if the satellite has both omnidirectional or directional antennas, their polarization is changing as the satellite rotates. But the spin fading is nearly always caused because the antenna's radiation pattern is obstructed or blocked by the satellite. This is when the satellite is between its antennas and the Earth station.

T8B10 - What is a LEO satellite? **A satellite in low earth orbit**

Explanation: LEO (low Earth orbit) means that the satellite is in an orbit that is close to Earth. LEO typically refers to satellites that are 1,000 km to as low as 160 km above Earth. Most other satellites are in orbits much higher above Earth. So the next time you see the initials LEO, you will know they refer to a low Earth orbiting amateur satellite.

T8B11 - Who may receive telemetry from a space station? **Anyone**

Explanation: Anyone who can receive the telemetry signal is allowed to receive telemetry from a space station. For some reason, the general public believes this is illegal or requires a special license or authorization. This is not the case! Anyone is allowed to receive telemetry data from a space station. However, you must have a license before you are allowed to transmit to a space station.

T8B12 - Which of the following is a way to determine whether your satellite uplink power is neither too low nor too high? **Your signal strength on the downlink should be about the same as the beacon**

Explanation: Verifying that your signal strength on the downlink is about the same as the beacon is a good way to judge whether your uplink power is either too low or too high. If your signal is too weak, it will be difficult for other stations to understand, and if your signal is too strong, you will shut down satellite access for everyone else. Comparing your signal to the satellite's beacon signal is a good indication that your amount of power and/or ERP (effective radiated power) is just about right.

T8C01 - Which of the following methods is used to locate sources of noise interference or jamming? **Radio direction finding**

Explanation: Radio direction finding is used to locate sources of noise interference or jamming. Direction finding consists of one or more stations equipped with a directional antenna, an attenuator and a receiver that is able to receive the offending signal. You first swing your directional antenna in a full 360-degree pattern and note any peaks in the offending signal. Next, move a little ways in the direction of the signal and take another reading. Each time you

stop to take a reading the signal should get stronger. When the signal is so strong you can't determine the actual direction, then you use your attenuator to reduce the signal to a manageable level and continue. Depending on the location and the power level, you should get a really good idea of the origin of the offending signal.

T8C02 - Which of these items would be useful for a hidden transmitter hunt? **A directional antenna**

Explanation: A directional antenna is an item that would be useful for a hidden transmitter hunt. Some amateur radio clubs sponsor hidden transmitter hunts throughout the year. An individual goes out in a predetermined area, usually within a several square mile area, and hides. He will periodically transmit a signal from his hidden radio location. This individual or radio is considered the fox. The "hound" stations are the ones hunting the fox. The hounds use directional antennas and radio receivers to determine the location of the fox. Usually afterward, the club has a picnic or cookout. Some countries even have the hidden transmitter activities as a sport with large turnouts.

T8C03 - What operating activity involves contacting as many stations as possible during a specified period? **Contesting**

Explanation: Some contests are designed to see how many countries -- or even counties within a state -- you can communicate with in a given time period, while other contests are designed to get you out of the house and operating under emergency conditions. Extra points are awarded for operating using emergency power and/or batteries. Other contests offer additional points for operating outside in February -- you get more points based on the local air temperatures. Contesting is a great way to learn more about this fascinating hobby.

T8C04 - Which of the following is good procedure when contacting another station in a contest? **Send only the minimum information needed for proper identification and the contest exchange**

Explanation: Sending only the minimum information needed for a proper identification and the contest exchange is a good procedure when contacting another station in a radio contest. Serious contesting stations do not wish to rag chew or discuss the weather, they only want to work the next station. The exchange information varies from contest to contest; you need to read the contest rules for the contest before entering.

T8C05 - What is a grid locator? **A letter-number designator assigned to a geographic location**

Explanation: Grid squares are very popular for VHF and UHF contacts. The ARRL has some great grid locator maps available for downloading directly from their website.

T8C06 - How is over the air access to IRLP nodes accomplished? **By using DTMF signals**

Explanation: IRLP (Internet Radio Linking Project) nodes are accessed by using DTMF (dual-tone multi-frequency) tones. Nearly all VHF/UHF mobile transceivers and handheld radios have these Touch-Tone keypads on either their front panel or integrated into their microphone. Some repeaters also require a password to be used in addition to the DTMF tones.

T8C07 - What is Voice Over Internet Protocol (VoIP)? **A method of delivering voice communications over the internet using digital techniques**

Explanation: Voice communications over the internet using digital techniques is VoIP (Voice Over Internet Protocol), which is used in ham radio. Several different areas of amateur radio use VoIP such as DMR and D-STAR.

T8C08 - What is the Internet Radio Linking Project (IRLP)? **A technique to connect amateur radio systems, such as repeaters, via the internet using Voice Over Internet Protocol (VoIP)**

Explanation: The Internet Radio Linking Project, also called IRLP, links amateur stations around the world by using voice over IP (VoIP). Each gateway consists of a dedicated computer running custom software that is connected to both a radio and the internet. This arrangement forms what is known as an IRLP node.

T8C09 - Which of the following protocols enables an amateur station to transmit through a repeater without using a radio to initiate the transmission? **EchoLink**

Explanation: Echolink is an option that repeater managers can add to their equipment that allows for a signal to be received from over the internet and transmitted over the air, as well as for that internet station to monitor the rest of the conversation. Echolink requires a smart phone or computer application and a login.

T8C10 - What is required before using the EchoLink system? **Register your call sign and provide proof of license**

Explanation: Before you may use the EchoLink system to communicate using a repeater, you first must register your call sign and provide proof of license. These measures are taken to ensure that unlicensed individuals are not given access to amateur airwaves. Anyone can access an EchoLink node over the internet, but by having the amateur register their call sign and provide proof of their license, the system administrators are able to verify only licensed operators are able to come out over the air in a remote location. Some hams don't own a radio but use their computer to carry on FM voice QSOs with other stations which are using a radio.

T8C11 - What is an amateur radio station that connects other amateur stations to the internet? **A gateway**

Explanation: A gateway station is the name given to an amateur station that is used to connect other stations to the internet. Many individuals miss this question because they answer digipeater. The digipeater is used to connect one station to another via RF. The gateway station is the interface between the amateur station and the internet. The key word here is Internet.

T8D01 - Which of the following is a digital communications mode? **All of these choices are correct**

Explanation: JT65, IEEE 801.11 and packet all are digital communications modes. The Technician class license give you access to a few of the digital communications modes. General and Extra class licenses give you access to all the different digital modes. JT65 is used primarily for EME (Earth-moon-Earth, moon bounce), IEEE 802.11 is primarily used for MESH or wireless networking and packet radio uses the AX.25 protocol.

T8D02 - What is a “talk group” on a DMR repeater? **A way for groups of users to share a channel at different times without hearing other users on the channel**

Explanation: A DMR talk group allows for sharing a conversation among a smaller group of users than can hear the whole repeater. One example would be different working groups on the same project, searchers could talk to other searchers, while leaders could talk to each other in separate discussions. DMR repeaters with internet connections can use regional, statewide and national talk groups.

T8D03 - What kind of data can be transmitted by APRS? **All these choices are correct**

Explanation: The Automatic Packet Reporting System, APRS, encodes data into digital packets and transmits it over the air. These small data packets can contain simple text data including weather conditions, GPS location and short messages.

T8D04 - What type of transmission is indicated by the term "NTSC?" **An analog fast scan color TV signal**

Explanation: NTSC (National Television System Committee) is the name of the standard used to encode colors in an analog fast-scan color TV signal. ATV (amateur television) is another mode of communications you are allowed to use with your license. Some larger cities have ATV repeaters.

T8D05 - Which of the following is an application of APRS? **Providing real-time tactical digital communications in conjunction with a map showing the locations of stations**

Explanation: APRS (Automatic Packet Reporting System) provides real-time tactical digital communications in conjunction with a map showing the locations of the

stations. At many high-profile amateur repeater sites, there usually is an APRS gateway radio to send the reporting information to the internet so your location can be tracked from anywhere in the world with internet access. The annual Rose Bowl Parade uses APRS in some of their floats so the event coordinators will have real-time location information of their key floats along the parade route.

T8D06 - What does the abbreviation "PSK" mean? **Phase Shift Keying**

Explanation: PSK-31 digital modes are very popular because of its keyboard-to keyboard capabilities.

T8D07 - Which of the following describes DMR? **A technique for time-multiplexing two digital voice signals on a single 12.5 kHz repeater channel**

Explanation: DMR (Digital Mobile Radio) is a technique for time-multiplexing two digital voice signals on a single 12.5 kHz-repeater channel. In other words, each DMR repeater has two different time slots for communications. This technique allows two simultaneous conversations to take place on the same repeater using the same 12.5kHz channel at the same time. This is a very efficient use of our precious amateur spectrum.

T8D08 - Which of the following is included in packet radio transmissions? **All of these choices are correct**

Explanation: The packet in packet transmissions contains several pieces of information, which includes automatic repeat request in case of an error, a header that contains the call sign of the station to which the information is being sent and a check sum that permits error detection. Amateur radio uses the AX.25 protocol standard for packet radio and is based on the X.25 protocol. Note that the "A" in AX.25 stands for amateur radio.

T8D09 - What is CW? **Another name for a Morse code transmission**

Explanation: International Morse code is used when sending CW in the amateur bands and is recognized all across the globe. American Morse code, or sometimes referred to as railroad Morse, was used by the early railroad telegraphers. The rest of the world adopted the international format.

T8D10 - Which of the following operating activities is supported by digital mode software in the WSJT-X software suite? **All of these choices are correct**

Explanation: The WSJT-X suite is a powerful software, allowing the use of a variety of digital modes designed for use in extremely weak signal situations, as well as other uses like meteor scatter and EME contacting. Some of the included modes are FT8, JT65, MSK144, and many more.

T8D11 What is an ARQ transmission system? **An error correction method in which the receiving station detects errors and sends a request for retransmission**

Explanation: A digital scheme whereby the receiving station detects errors and sends a request to the sending station to retransmit the information is called an ARQ transmission system. ARQ (automatic repeat request) is sometimes referred to as automatic repeat query, an error-control method for amateur digital data transmissions.

T8D12 - Which of the following best describes an amateur radio mesh network? **An amateur radio based data network using commercial Wi-Fi equipment with modified firmware**

Explanation: An amateur radio-based data network using commercial Wi-Fi gear with modified firmware best describes Broadband-Hamnet (TM), also referred to as an HSMM (high-speed multimedia) network. Many clubs use this configuration for their on-the-air events with multiple stations on the air at the same time. All the stations are networked together using the mesh network protocol and off-the-shelf commercial wireless routers running modified firmware. This multimedia aspect also allows VoIP or individual telephones for voice communications between the different stations on the network.

T8D13 - What is FT8? **A digital mode capable of low signal-to-noise operation**

Explanation: FT8 is a digital mode capable of operating in low signal-to-noise conditions that transmits on 15-second intervals. FT8 was developed by Joe Taylor, K1JT, and Steve Franke, K9AN, thus "FT," and the signal is 8-FSK, thus the 8. FT8 allows your station to auto sequence from one message to the next for quick and efficient communications. FT8 typically allows communications with stations that have a signal-to-noise ratio of -10 dB to -15 dB with no problem.

T9 – Antennas

T9A01 - What is a beam antenna? **An antenna that concentrates signals in one direction**

Explanation: The typical beam antenna consists of one or more elements along a common boom. Beam antennas can be either vertically polarized for VHF/UHF FM activities or horizontally polarized for HF SSB/CW operation.

T9A02 - Which of the following describes a type of antenna loading? **Electrically lengthening by inserting inductors in radiating elements**

Explanation: Inserting an inductor in the radiating portion of the antenna to make it electrically longer describes a type of antenna loading. Inductors inserted in series with the radiating portion of the antenna will make the antenna appear electrically longer to your amateur transmitter. This technique is useful when you have limited space for your low-frequency antennas. They can be physically shorter, but electrically, they will be proper length.

T9A03 - Which of the following describes a simple dipole oriented parallel to the Earth's surface? **A horizontally polarized antenna**

Explanation: Vertically polarized antennas usually have a lower angle of radiation, while horizontal polarized antennas have a higher angle of take-off. The means when signals from a vertical bounce back to Earth they will land much farther away from the antenna than the signals from a horizontal antenna.

T9A04 - What is a disadvantage of the short, flexible antenna supplied with most handheld radio transceivers, compared to a full-sized quarter-wave antenna? **It has low efficiency**

Explanation: The disadvantage of the "rubber duck" antenna supplied with most handheld radio transceivers when compared to a full-sized quarter-wave antenna is that they do not transmit or receive as effectively. Rubber duck antennas offer more convenience than performance. There is nothing wrong with owning two separate antennas for your handheld radio. The rubber duck can be used for close-quarter or tactical communications where most everyone or the repeater is line of sight. A quarter-wave antenna can be substituted for conditions where performance is a priority such as hiking or locations farther away from other individuals or the repeater.

T9A05 - Which of the following increases the resonant frequency of a dipole antenna? **Shorten it**

Explanation: Shortening a dipole antenna will make it resonant on a higher frequency. Just think of the musical instrument with strings: the shorter the string, the higher the frequency; the longer the strings, the lower in frequency. If your antenna presents a high SWR on the frequency you wish to operate, then look at the SWR above your frequency and below your frequency. If the SWR is better below your current frequency you know you will have to shorten your antenna to raise its resonant frequency.

T9A06 - Which of the following types of antenna offers the greatest gain? **Yagi**

Explanation: The Yagi antenna is a directional antenna and offers the greatest gain. If you are unable to increase your radio's power output, antenna gain can offer you an advantage of more power through antenna performance and design!

T9A07 What is a disadvantage of using a handheld VHF transceiver with a flexible antenna inside a vehicle? **Signal strength is reduced due to the shielding effect of the vehicle**

Explanation: A disadvantage of using a handheld VHF transceiver with its integral antenna inside a vehicle while mobile is that signals might not propagate well because of the vehicle's shielding effect. If practical, an external magnetic mount antenna will deliver superior performance. Also be aware that some cities and states have laws about operating handheld electronic devices while driving. Some vehicles have material in the window tinting that also has a shielding effect on VHF and UHF frequencies. Think safety.

T9A08 - What is the approximate length, in inches, of a quarter-wavelength vertical antenna for 146 MHz? **19**

Explanation: The approximate length, in inches, of a quarter-wavelength vertical antenna for 146 MHz will be 19 inches. Let's break down the math: they want the length on an antenna in inches based on a given frequency. The tried-and-true formula for quarter-wavelength antennas is divide 234 by the

frequency in MHz. 234 / frequency in MHz = Antenna length in feet. Therefore, 234 / 146 MHz = 1.602 feet. To convert feet to inches, multiply by 12. Therefore, 1.602 feet x 12 = 19.2 inches.

T9A09 - What is the approximate length, in inches, of a half-wavelength 6 meter dipole antenna? **112**

Explanation: The approximate length, in inches, of a half-wavelength 6-meter dipole antenna is 112.32 inches. Let's break down the math: they want the length of a half wavelength antenna in inches based on a given wavelength. First let's get our wavelength to a frequency using 300 divided by wavelength in meters, which is equal to the frequency in megahertz. 300 / 6 meters = 50 MHz. Now that we have our frequency (50 MHz), let's use the tried-and-true formula for a half-wavelength antenna: 468 / frequency in MHz = antenna length in feet. 468 / 50 MHz = 9.36 feet. To convert to inches, take 9.36 feet x 12 = 112.32 inches.

T9A10 - In which direction does a half-wave dipole antenna radiate the strongest signal? **Broadside to the antenna**

Explanation: This means if your half-wave dipole antenna runs north and south, the strongest gain will be east and west.

T9A11 - What is antenna gain? **The increase in signal strength in a specified direction compared to a reference antenna**

Explanation: In this case, you can calculate gain by comparing the measured signal either transmitted or received in a specified direction to the signal transmitted or received by a hypothetical ideal antenna in the same situation. The value of gain is expressed in dB.

T9A12 - What is an advantage of a 5/8 wavelength whip antenna for VHF or UHF mobile service? **It has more gain than a 1/4-wavelength antenna**

Explanation: Therefore, the 5/8-wavelength antenna has longer range and more gain when compared to the 1/4 wavelength antenna.

T9B01 - What is a benefit of low SWR? **Reduced signal loss**

Explanation: While 1 SWR is considered ideal, anything less than 2 SWR will ensure that your radio is working well. High SWR (2.5+) is a signifier that your antenna is being used inefficiently.

T9B02 - What is the most common impedance of coaxial cables used in amateur radio? **50 ohms**

Explanation: 50 ohms is the impedance of most coaxial cables used in amateur installations. Nearly all amateur radio transmitters are designed to use coaxial feed lines with a 50-ohm impedance. The coaxial cable used for television, CATV, cable and satellite installations is all 75 ohm. At first glance, the cable looks the same, but a close examination of the cable type printed on the jacket will allow you to reference the specifications on a data sheet.

T9B03 - Why is coaxial cable the most common feed line for amateur radio antenna systems? **It is easy to use and requires few special installation considerations**

Explanation: Coaxial cable is the most common feed line selected for amateur radio antenna systems because it is easy to use and requires few special installation considerations. Coaxial cable can be easily stuffed through a window or through a wall and can easily be strapped or taped to the leg of a tower going to the antenna on top. Open wire feed lines, on the other hand, are not that robust. Open wire feed lines must not be strapped directly to metal such as a tower leg; they need to be held at least 8 inches or more away from the metal leg. Open wire feed lines need to be insulated when penetrating walls or metal window frames. Open wire feed lines cannot be bundled with other coaxial cables because of the interaction with the braid (ground) on each of the cables.

T9B04 - What is the major function of an antenna tuner (antenna coupler)? **It matches the antenna system impedance to the transceiver's output impedance**

Explanation: If the mismatch is too great, the antenna tuner will absorb the energy mismatch and convert the energy that was not transferred to the antenna into heat.

T9B05 What happens as the frequency of a signal in coaxial cable is increased? **The loss increases**

Explanation: This is why coaxial cable used in VHF and UHF installations cost more than coaxial cable used on HF frequencies. Longer runs of coaxial cable for VHF and UHF installations should be avoided, if possible. Your antenna system is one of the most important pieces of your station.

T9B06 - Which of the following RF connector types is most suitable for frequencies above 400 MHz? **Type N**

Explanation: Type N connectors are most suitable for frequencies above 400 MHz. They have less loss than other types of coaxial cable connectors. Also, N connectors have much better shielding than other connectors rated for HF use. The extra shielding keeps stray RF from leaking out of the connector and also helps prevent strong RF fields from leaking into the system. Type N connectors are available in both solder and crimp styles.

T9B07 - Which of the following is true of PL-259 type coax connectors? **They are commonly used at HF and VHF frequencies**

Explanation: PL-259 type coax connectors are commonly used at HF frequencies. They are fairly inexpensive and are easy to install on coaxial cable. You can find PL259 connectors in both solder and crimp-on styles.

T9B08 - Which of the following is a source of loss in coaxial feed line? **All of these choices are correct**

Explanation: If you have water intrusion into a coaxial connector, high SWR or multiple connectors in line, you could be experiencing a loss in your coaxial feedline. Thus, “all of these choices” is the correct answer on the exam.

T9B09 - What can cause erratic changes in SWR? **Loose connection in the antenna or feed line**

Explanation: A loose connection in an antenna or feed line can cause erratic changes in SWR (standing wave ratio) readings. Moisture in the coax from improper weatherproofing is another cause of erratic SWR readings. These problems can be easily reduced by good mechanical and electrical bonding of all connections and weather proofing.

T9B10 - What is the electrical difference between RG-58 and RG-213 coaxial cable? **RG-213 cable has less loss at a given frequency**

Explanation: The electrical difference between RG-58 and RG-213 coaxial cable is that RG-213 cable has less loss at a given frequency. With coaxial cable, the higher the frequency, the greater the loss. Also the longer the run of coaxial cable the more losses that are introduced into the antenna system. In your initial planning, take into consideration the frequencies you will be operating and the distance of the antennas from your transmitter(s). Having your 250-foot tower 100 feet from your station is great, but if more than half your signal is being lost in the coaxial cable, locating the tower closer to the station and locating your UHF antennas partly up the tower would be a good start in reducing your cable losses unless you move to 2-inch hardline cable.

T9B11 - Which of the following types of feed line has the lowest loss at VHF and UHF? **Air-insulated hard line**

Explanation: Air-insulated hard line is a type of feed line that has the lowest loss at VHF and UHF frequencies. The larger the coaxial cable, the more difficult it becomes to work with. Hard line cable is not very flexible. Coaxial connectors for the larger coax sometimes can cost more than $50 each. Most high-powered commercial installations use air-insulated hard line coaxial feed lines because of the low loss. Many times this cable finds its way into the hands of lucky hams.

T10 – Safety

T0A01 - Which of the following is a safety hazard of a 12-volt storage battery? **Shorting the terminals can cause burns, fire, or an explosion**

Explanation: One of the safety hazards of a 12-volt storage battery occurs when you short the terminals, which can cause burns, fire or an explosion. Use extreme caution when working with 12-volt storage or lead acid batteries. Rapid charging and discharging a lead acid battery can generate hydrogen gas, which is very explosive. One spark from a relay or switch in your repeater shack full of hydrogen gas can cause a serious fire or explosion. The same goes for your ham shack, which always should have an area where batteries are kept well-ventilated and free of combustible materials.

T0A02 - What health hazard is presented by electrical current flowing through the body? **All of these choices are correct**

Explanation: Involuntary muscle contractions, disruption of the electrical functions of cells and injury to tissue because of heating are some of the health hazards presented by electrical current flowing through the body. Please use extreme caution when working in and around energized electrical circuits. One good rule of thumb is to always keep one hand in your pocket when working around high-voltage amplifiers. Please think safety!

T0A03 In the United States, what circuit does black wire insulation indicate in a three-wire 120 V cable? **Hot**

Explanation: In the United States, equipment ground is connected to the hot wire in a three-wire electrical AC plug. If you are unsure or have questions about AC house wiring or connections, please consult with a professional.

T0A04 - What is the purpose of a fuse in an electrical circuit? **To remove power in case of overload**

Explanation: The fuse not only protects the equipment, but it can also prevent a dangerous situation such as equipment overheating or an electrical fire.

T0A05 - Why should a 5-ampere fuse never be replaced with a 20-ampere fuse? **Excessive current could cause a fire**

Explanation: A fuse protects a circuit from overload. Replacing a smaller fuse with a larger one increases the risk of overload on the components and could cause fires or other damage to the circuits.

T0A06 - What is a good way to guard against electrical shock at your station? **All of these choices are correct**

Explanation: Using three-wire cords and plugs for AC-powered equipment, connecting all AC-powered station equipment to a common safety ground and using a circuit protected by a ground-fault interrupter are all good ways to guard against electrical shock at your station. If you have any questions or concerns, please consult with a licensed electrician or professional concerning your amateur station AC house wiring.

T0A07 - Where should a lightning arrester be installed in a coaxial feed line? **On a grounded panel near where feed lines enter the building**

Explanation: Arresting lightning outside your home is the best protection for your equipment. Other options listed do not keep the energy outside the home.

T0A08 - Where should a fuse or circuit breaker be installed in a 120V AC power circuit? **In series with the hot conductor only**

Explanation: A fuse or circuit breaker in series with the AC hot conductor is one piece of safety equipment that always should be included in home-built equipment that is powered from 120-volt AC

power circuits. Interlocks to remove AC power from homebuilt equipment when the cover is removed is another example of safety equipment that can be installed.

T0A09 - What should be done to all external ground rods or earth connections? **Bond them together with heavy wire or conductive strap**

Explanation: A good practice is for all external ground rods or Earth connections to be bonded together with heavy wire or conductive strap. The ARRL has an excellent book on this subject written by H. Ward Silver.

T0A10 - What hazard is caused by charging or discharging a battery too quickly? **Overheating or out-gassing**

Explanation: The battery could overheat, give off flammable gas or explode if a lead acid storage battery is charged or discharged too quickly. Keep the area where the battery is located well-ventilated at all times. Anytime you are working with or charging lead-acid batteries, wear acid-resistant goggles and face shield, acid-resistant gloves and, if possible an acid-resistant apron. Lead-acid batteries can deliver a very high amount of current. Always use fuses as close to the battery as possible to minimize any damage in case of a short circuit. If these batteries are improperly fused, they can easily start an electrical fire if a circuit fault occurs. Remember: safety first.

T0A11 - What hazard exists in a power supply immediately after turning it off? **Charge stored in filter capacitors**

Explanation: Capacitors store energy in a circuit, including power supplies. When a power supply is first turned off, it takes some time for the current stored in the capacitors to discharge. So a charged capacitor is a risk in this case.

T0A12 - Which of the following precautions should be taken when measuring high voltages with a voltmeter? **Ensure that the voltmeter and leads are rated for use at the voltages to be measured**

Explanation: Not all voltmeters are designed to measure all voltages. The circuits being measured could overheat, or the leads could be undersized for the job. Check your voltmeter's rating before measuring high voltage circuits.

T0B01 - Which of the following is good practice when installing ground wires on a tower for lightning protection? **Ensure that connections are short and direct**

Explanation: The quicker you can get lightning to ground the better. Short and direct connections allow for that.

T0B02 - What is required when climbing an antenna tower? **All of these choices are correct.**

Putting on a carefully inspected climbing harness (fall arrester) and
safety glasses is a good precaution to observe before climbing an antenna or tower. Also never work alone when performing antenna or tower maintenance. If you are unsure or inexperienced with tower and antenna work, please hire an expert or professional. Many two-way radio shops have hams who work in various positions in that company. Getting advice from a professional who performs commercial work every day and is a ham is invaluable. Remember: Think safety first.

T0B03 - Under what circumstances is it safe to climb a tower without a helper or observer? **Never**

Explanation: Under any circumstances, it never is safe to climb a tower without a helper or observer. Having a helper even if they are an inexperienced family member can prove invaluable when it comes to you needing a tool or fastener while working on top of the tower. They can at least put the needed material in a bucket so you can pull it up with a rope. This is much better than making many trips up and down the tower for parts and pieces that were not anticipated during the planning stages.

T0B04 - Which of the following is an important safety precaution to observe when putting up an antenna tower? **Look for and stay clear of any overhead electrical wires**

Explanation: An important safety precaution to observe when putting up an antenna or tower is to always look for and stay clear of any overhead electrical wires. Some tower installations also utilize guy wires as part of the design. Also take into account the guy wire placement in relation to any existing power lines. Remember: Think about safety first.

T0B05 - What is the purpose of a safety wire through a turnbuckle used to tension guy lines? **Prevent loosening of the turnbuckle from vibration**

Explanation: A turnbuckle tightens two pieces of guy lines to strengthen their connections using screw threads. To keep that from unscrewing, safety wire is used.

T0B06 - What is the minimum safe distance from a power line to allow when installing an antenna? **Enough so that if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power wires**

Explanation: When choosing the location for your tower and/or antenna, you need to ensure that if your antenna or tower falls unexpectedly that no part of it can come closer than 10 feet to power lines. This is the minimum safe distance. Also be aware, depending on the type of power line and the voltage on the power line, that you may encounter "line noise" emitted from the power line. A best practice is to remain as far away from any power line as possible. Remember: Think safety. Sometimes running your wire antennas perpendicular to the power lines, instead of parallel, will help minimize the amount of line noise you receive.

T0B07 - Which of the following is an important safety rule to remember when using a crank-up tower? **This type of tower must not be climbed unless it is retracted, or mechanical safety locking devices have been installed**

Explanation: A crank up tower is designed to go up and down with ease, which is a risk when climbing. Using the proper locking devices or retracting the tower is the safest way to access it.

T0B08 - What is considered to be a proper grounding method for a tower? **Separate eight-foot long ground rods for each tower leg, bonded to the tower and each other**

Explanation: The proper grounding method for a tower is separate eight-foot-long ground rods for each tower leg, bonded to the tower and each other. The ARRL has an excellent book written by Ward Silver. Remember: Think safety. If you have questions or you are unsure of your tower and antenna installation, please consult with licensed professionals.

T0B09 - Why should you avoid attaching an antenna to a utility pole? **The antenna could contact high-voltage power lines**

Explanation: You should avoid attaching an antenna to a utility pole because your antenna could contact high-voltage power lines. Think safety when working around power lines. It is considered a best practice to locate all antennas as far as possible away from existing power lines. This not only safe, but also reduces the chance of unwanted line noise being received by your station.

T0B10 - Which of the following is true when installing grounding conductors used for lightning protection? **Sharp bends must be avoided**

Explanation: Lightning likes to travel in a straight line. Lightning can't flow through conductors that make sharp turns and possibly could jump from the grounding conductor to surrounding equipment at the point of the sharp bend or turn. The potential for additional damage and possible fire hazard is possible with grounding conductors that do not follow a straight line.

T0B11 - Which of the following establishes grounding requirements for an amateur radio tower or antenna? **Local electrical codes**

Explanation: If there are questions or you are unsure about anything related to your tower or antenna installation, ask a professional. Many city codes are not the same from city to city or from state to state. Ask an expert when in doubt. Remember: Think safety.

T0C01 - What type of radiation are radio signals? **Non-ionizing radiation** Non-ionizing is the type of radiation in VHF and UHF radio signals. Non-
ionizing radiation travels at the speed of light. The non-ionizing radiation energy is composed of electric and magnetic fields. The frequency spectrum for non-ionization radiation includes UV (ultraviolet), visible light, IR (infrared light), MW (microwave), RF (radio frequency) and ELF (extremely low frequency). Ionizing radiation consists of gamma rays, X-rays and above into the electromagnetic spectrum.

T0C02 - At which of the following frequencies does maximum permissible exposure have the lowest value? **50 MHz**

Explanation: 50 MHz has the lowest value for maximum permissible exposure limit. The FCC has determined that the human body can easily absorb frequencies between 30 MHz and 300 MHz. This range requires the lowest exposure. The closest amateur band within this range is the 6-meter band, or 50 MHz.

T0C03 - How does the allowable power density for RF safety change if duty cycle changes from 100 percent to 50 percent? **It increases by a factor of 2**

Explanation: The concept here is if you are transmitting half as much, you can be around it twice as long and have the same impact. If you are transmitting every 30 seconds and are allowed 2 minutes of exposure, by switching to transmitting every 60 seconds (half as often) you are allowed 4 minutes of exposure (twice as long).

T0C04 - What factors affect the RF exposure of people near an amateur station antenna? **All of these choices are correct**

Explanation: The FCC has set RF exposure limits based on these factors. As a licensed amateur radio operator, you are expected to perform an RF exposure survey of your station. In nearly all cases, most amateur stations will be exempt because they do not exceed the frequency and power level limits. But documenting the fact you are exempt is a best practice and be sure to keep this information in your station records.

T0C05 - Why do exposure limits vary with frequency? **The human body absorbs more RF energy at some frequencies than at others**

Explanation: The human body absorbs more RF energy at some frequencies than other frequencies, thus exposure limits vary with the frequency. Studies have shown that lower RF frequencies can penetrate the human body. Scientific evidence suggests that RF waves in the range 300 MHz to 3 GHz can be harmful for human health.

T0C06 - Which of the following is an acceptable method to determine whether your station complies with FCC RF exposure regulations? **All of these choices are correct** Explanation: Calculations based on FCC OET Bulletin 65, based on computer modeling, and measurement of field strength using calibrated equipment are all acceptable methods to determine that your station complies with FCC RF exposure regulations. Any time you make changes to your station, a good practice is to reevaluate your RF Exposure limits after all changes have been completed.

T0C07 - What hazard is created by touching an antenna during a transmission? **RF burn to skin**

Explanation: Because part of the burn is below the skin's surface, seek immediate medical attention. Remember: think safety. Most ham antennas are positioned out of the reach of the general public.

T0C08 - Which of the following actions can reduce exposure to RF radiation? **Relocate antennas**

Explanation: Relocating antennas is an action an amateur radio operator can take to prevent exposure to RF radiation in excess of the FCC-supplied limits. Limiting the amount of time you are in the field of radiation from the antenna is another action an amateur radio operator can take to prevent exposure to RF radiation, except it is not always practical. Increasing the distance between you and the antenna is the easiest way to limit your radiation exposure. The distance from your antenna is inversely proportional to the square of the distance. For example, if you double the distance from your antenna, you reduce the radiation exposure by a fourth. If you are 5 feet from your antenna and the exposure at your body is 100 watts, then if you move another 5 feet from the antenna (double the distance) your RF exposure to your body is now 25 watts.

T0C09 - How can you make sure your station stays in compliance with RF safety regulations? **By re-evaluating the station whenever an item in the transmitter or antenna system is changed**

Explanation: Re-evaluating your amateur station whenever an item of equipment is changed or reconfigured is one way you can make sure your station stays in compliance with RF safety regulations. The best practice is to keep all your RF evaluation information and station configuration information with your station records. In the unlikely event the FCC asks for your station documentation, everything will be together in one place. Many operators keep the configuration changes in their log book on the blank pages. They then always have the permanent log and configuration of their station. This is very handy to document when you buy each piece of equipment. Finally, if a little one disconnects some of your pretty cables, you have the latest connection diagrams with your station configuration.

T0C10 - Why is duty cycle one of the factors used to determine safe RF radiation exposure levels? **It affects the average exposure to radiation**

The transmitter's duty cycle is one of the factors used to determine safe RF radiation exposure levels as it affects the average exposure of people to radiation. The FCC and OSHA uses the time, distance and shielding for limiting factors concerning RF exposure. You limit the time you are close to the radiating source, you increase the distance between you and the radiating source and you employ any shielding that can be maneuvered between you and the antenna or radiating source, such as a metal building or foil-backed insulation.

T0C11 - What is the definition of duty cycle during the averaging time for RF exposure? **The percentage of time that a transmitter is transmitting**

Explanation: The definition of duty cycle during the averaging time for RF exposure is the percentage of time that a transmitter is transmitting. The amateur radio station's duty cycle is used in many different calculations to answer questions found in FCC exams. How long the transmitter is transmitting versus the amount of time the transmitter is off and the receiver is active is basically your duty cycle. This calculation is also very important when calculating power supply capacity and power capabilities of antennas and baluns.

T0C12 - How does RF radiation differ from ionizing radiation (radioactivity)? **RF radiation does not have sufficient energy to cause chemical changes in cells and damage DNA**

Explanation: The difference from RF radiation to ionizing radiation (radioactivity) is that RF radiation does not have sufficient energy to cause genetic damage. Ionizing radiation includes radiation sources such as X-rays and gamma rays.

T0C13 - Who is responsible for ensuring that no person is exposed to RF energy above the FCC exposure limits? **The station licensee**

Explanation: When in doubt, you are responsible for everything your amateur radio station does. This includes when you transmit, what you transmit, and who is exposed to the RF energy from your signal.