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Exam	Page	Rule	Question	Answer
T07D05	0-00		Question Removed (section not renumbered)	
T05B01	2-02		How many milliamperes is 1.5 amperes?	1500 milliamperes
T05B02	2-02		Which is equal to 1,500,000 hertz?	1500 kHz
T05B03	2-02		Which is equal to one kilovolt?	One thousand volts
T05B04	2-02		Which is equal to one microvolt?	One one-millionth of a volt
T05B05	2-02		Which is equal to 500 milliwatts?	0.5 watts
T05B06	2-02		Which is equal to 3000 milliamperes?	3 amperes
T05B07	2-02		Which is equal to 3.525 MHz?	3525 kHz
T05B08	2-02		Which is equal to 1,000,000 picofarads?	1 microfarad
T05B12	2-02		Which is equal to 28400 kHz?	28.400 MHz
T05B13	2-02		Which is equal to 2425 MHz?	2.425 GHz
T05A06	2-03		What is the unit of frequency?	Hertz
T05A12	2-03		What describes the number of times per second that an alternating current makes a complete cycle?	Frequency
T05C07	2-03		What is the abbreviation for megahertz?	MHz
T05C13	2-03		What is the abbreviation for kilohertz?	kHz
T03B08	2-04		What frequency range is referred to as VHF?	30 MHz to 300 MHz
T03B09	2-04		What frequency range is referred to as UHF?	300 to 3000 MHz
T03B10	2-04		What frequency range is referred to as HF?	3 to 30 MHz
T05C06	2-04		What does the abbreviation “RF” mean?	Radio frequency signals of all types
T03B04	2-05		What is the velocity of a radio wave traveling through free space?	Speed of light
T03B05	2-05		What is the relationship between wavelength and frequency?	Wavelength gets shorter as frequency increases
T03B06	2-05		What is the formula for converting frequency to approximate wavelength in meters?	Wavelength in meters equals 300 divided by frequency in megahertz
T03B07	2-05		In addition to frequency, which of the following is used to identify amateur radio bands?	The approximate wavelength in meters
T03B11	2-05		What is the approximate velocity of a radio wave in free space?	300,000,000 meters per second
T07A02	2-07		What is a transceiver?	A device that combines a receiver and transmitter
T01F09	2-08	[97.3(a)(40)]	What type of amateur station simultaneously retransmits the signal of another amateur station on a different channel or channels?	Repeater station

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T05A01	3-01		Electrical current is measured in which of the following units?	Amperes
T05A03	3-01		What is the name for the flow of electrons in an electric circuit?	Current
T05A05	3-01		What is the electrical term for the force that causes electron flow?	Voltage
T05A09	3-01		Which of the following describes alternating current?	Current that alternates between positive and negative directions
T07D01	3-01		Which instrument would you use to measure electric potential?	A voltmeter
T07D04	3-01		Which instrument is used to measure electric current?	An ammeter
T05D13	3-02		In which type of circuit is DC current the same through all components?	Series
T05D14	3-02		In which type of circuit is voltage the same across all components?	Parallel
T07D02	3-02		How is a voltmeter connected to a component to measure applied voltage?	In parallel
T07D03	3-02		When configured to measure current, how is a multimeter connected to a component?	In series
T07D06	3-04		Which of the following can damage a multimeter?	Attempting to measure voltage when using the resistance setting
T07D07	3-04		Which of the following measurements are made using a multimeter?	Voltage and resistance
T07D10	3-04		What reading indicates that an ohmmeter is connected across a large, discharged capacitor?	Increasing resistance with time
T07D11	3-04		Which of the following precautions should be taken when measuring in-circuit resistance with an ohmmeter?	Ensure that the circuit is not powered
T10A12	3-04		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
T05A04	3-05		What are the units of electrical resistance?	Ohms
T05A07	3-05		Why are metals generally good conductors of electricity?	They have many free electrons
T05A08	3-05		Which of the following is a good electrical insulator?	Glass
T05A11	3-05		What type of current flow is opposed by resistance?	All these choices are correct/1. Direct current/2. Alternating current/3. RF current
T05D01	3-05		What formula is used to calculate current in a circuit?	I = E / R
T05D02	3-05		What formula is used to calculate voltage in a circuit?	E = I x R
T05D03	3-05		What formula is used to calculate resistance in a circuit?	R = E / I
T05D04	3-06		What is the resistance of a circuit in which a current of 3 amperes flows when connected to 90 volts?	30 ohms 90 volts/3 amperes = 30 ohms

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T05D05	3-06		What is the resistance of a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?	8 ohms 12 volts / 1.5 amperes = 8 ohms
T05D06	3-06		What is the resistance of a circuit that draws 4 amperes from a 12-volt source?	3 ohms 12 volts / 4 amperes = 3 ohms
T05D07	3-06		What is the current in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?	1.5 amperes 120 volts / 80 ohms = 1.5 amperes
T05D08	3-06		What is the current through a 100-ohm resistor connected across 200 volts?	2 amperes 200 volts / 100 ohms = 2 amperes
T05D09	3-06		What is the current through a 24-ohm resistor connected across 240 volts?	10 amperes 240 volts / 24 ohms = 10 amperes
T05D10	3-06		What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?	1 volt 0.5 amperes x 2 ohms = 1 volt
T05A02	3-07		Electrical power is measured in which of the following units?	Watts
T05A10	3-07		Which term describes the rate at which electrical energy is used?	Power
T05C08	3-07		What is the formula used to calculate electrical power (P) in a DC circuit?	$P = I \times E$
T05C09	3-07		How much power is delivered by a voltage of 13.8 volts DC and a current of 10 amperes?	138 watts 13.8 volts x 10 amperes = 138 watts
T05C10	3-07		How much power is delivered by a voltage of 12 volts DC and a current of 2.5 amperes?	30 watts 12 volts x 2.5 amperes = 30 watts
T05C11	3-07		How much current is required to deliver 120 watts at a voltage of 12 volts DC?	10 amperes 120 watts / 12 volts = 10 amperes
T05D11	3-07		What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?	10 volts 1 ampere x 10 ohms = 10 volts
T05D12	3-07		What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?	20 volts 2 amperes x 10 ohms = 20 volts
T05C01	3-08		What describes the ability to store energy in an electric field?	Capacitance
T05C02	3-08		What is the unit of capacitance?	The farad
T05C03	3-08		What describes the ability to store energy in a magnetic field?	Inductance
T05C04	3-08		What is the unit of inductance?	The henry

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T06A01	3-08		What electrical component opposes the flow of current in a DC circuit?	Resistor
T06A02	3-08		What type of component is often used as an adjustable volume control?	Potentiometer
T06A03	3-08		What electrical parameter is controlled by a potentiometer?	Resistance
T06A04	3-08		What electrical component stores energy in an electric field?	Capacitor
T06A05	3-08		What type of electrical component consists of conductive surfaces separated by an insulator?	Capacitor
T06A06	3-08		What type of electrical component stores energy in a magnetic field?	Inductor
T06A07	3-08		What electrical component is typically constructed as a coil of wire?	Inductor
T06D06	3-08		What component changes 120 V AC power to a lower AC voltage for other uses?	Transformer
T05C05	3-10		What is the unit of impedance?	The ohm
T05C12	3-10		What is impedance?	The opposition to AC current flow
T06B01	3-10		Which is true about forward voltage drop in a diode?	It is lower in some diode types than in others
T06B02	3-10		What electronic component allows current to flow in only one direction?	Diode
T06B03	3-10		Which of these components can be used as an electronic switch?	Transistor
T06B04	3-10		Which of the following components can consist of three regions of semiconductor material?	Transistor
T06B05	3-10		What type of transistor has a gate, drain, and source?	Field-effect
T06B06	3-10		How is the cathode lead of a semiconductor diode often marked on the package?	With a stripe
T06B07	3-10		What causes a light-emitting diode (LED) to emit light?	Forward current
T06B08	3-10		What does the abbreviation FET stand for?	Field Effect Transistor
T06B09	3-10		What are the names for the electrodes of a diode?	Anode and cathode
T06D08	3-10		Which of the following is combined with an inductor to make a resonant circuit?	Capacitor
T06D11	3-10		Which of the following is a resonant or tuned circuit?	An inductor and a capacitor in series or parallel
T06B10	3-11		Which of the following can provide power gain?	Transistor
T06B11	3-11		What is the term that describes a device's ability to amplify a signal?	Gain
T06B12	3-11		What are the names of the electrodes of a bipolar junction transistor?	Emitter, base, collector
T06D01	3-11		Which of the following devices or circuits changes an alternating current into a varying direct current signal?	Rectifier
T06D07	3-11		Which of the following is commonly used as a visual indicator?	LED
T06D09	3-11		What is the name of a device that combines several semiconductors and other components into one package?	Integrated circuit

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T06D10	3-11		What is the function of component 2 in figure T-1?	Control the flow of current
T06A09	3-12		What electrical component is used to protect other circuit components from current overloads?	Fuse
T10A04	3-12		What is the purpose of a fuse in an electrical circuit?	To remove power in case of overload
T10A05	3-12		Why should a 5-ampere fuse never be replaced with a 20-ampere fuse?	Excessive current could cause a fire
T06A08	3-13		What is the function of an SPDT switch?	A single circuit is switched between one of two other circuits
T06A12	3-13		What type of switch is represented by component **3** in figure T-2?	Single-pole single-throw
T06D02	3-13		What is a relay?	An electrically-controlled switch
T06C01	3-14		What is the name of an electrical wiring diagram that uses standard component symbols?	Schematic
T06C02	3-14		What is component 1 in figure T-1?	Resistor
T06C03	3-14		What is component 2 in figure T-1?	Transistor
T06C04	3-14		What is component 3 in figure T-1?	Lamp
T06C05	3-14		What is component 4 in figure T-1?	Battery
T06C06	3-14		What is component 6 in figure T-2?	Capacitor
T06C07	3-14		What is component 8 in figure T-2?	Light emitting diode
T06C08	3-14		What is component 9 in figure T-2?	Variable resistor
T06C09	3-14		What is component 4 in figure T-2?	Transformer
T06C10	3-14		What is component 3 in figure T-3?	Variable inductor
T06C11	3-14		What is component 4 in figure T-3?	Antenna
T06C12	3-14		Which of the following is accurately represented in electrical schematics?	Component connections
T06D04	3-14		Which of the following displays an electrical quantity as a numeric value?	Meter
T07A05	3-17		What is the name of a circuit that generates a signal at a specific frequency?	Oscillator
T07A08	3-17		Which of the following describes combining speech with an RF carrier signal?	Modulation
T07A03	3-18		Which of the following is used to convert a signal from one frequency to another?	Mixer

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T03A01	4-01		Why do VHF signal strengths sometimes vary greatly when the antenna is moved only a few feet?	Multipath propagation cancels or reinforces signals
T03A02	4-01		What is the effect of vegetation on UHF and microwave signals?	Absorption
T03A06	4-01		What is the meaning of the term “picket fencing”?	Rapid flutter on mobile signals due to multipath propagation
T03A07	4-01		What weather condition might decrease range at microwave frequencies?	Precipitation
T03A08	4-01		What is a likely cause of irregular fading of signals propagated by the ionosphere?	Random combining of signals arriving via different paths
T03A10	4-01		What effect does multi-path propagation have on data transmissions?	Error rates are likely to increase
T03A12	4-01		What is the effect of fog and rain on signals in the 10 meter and 6 meter bands?	There is little effect
T03C05	4-01		Which of the following effects may allow radio signals to travel beyond obstructions between the transmitting and receiving stations?	Knife-edge diffraction
T03C06	4-01		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
T03C08	4-02		What causes tropospheric ducting?	Temperature inversions in the atmosphere
T03C11	4-02		Why is the radio horizon for VHF and UHF signals more distant than the visual horizon?	The atmosphere refracts radio waves slightly
T03A11	4-03		Which region of the atmosphere can refract or bend HF and VHF radio waves?	The ionosphere
T03C01	4-03		Why are simplex UHF signals rarely heard beyond their radio horizon?	UHF signals are usually not propagated by the ionosphere
T03C02	4-03		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
T03C03	4-03		What is a characteristic of VHF signals received via auroral backscatter?	They are distorted and signal strength varies considerably
T03C04	4-03		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
T03C07	4-03		What band is best suited for communicating via meteor scatter?	6 meters
T03C09	4-03		What is generally the best time for long-distance 10 meter band propagation via the F region?	From dawn to shortly after sunset during periods of high sunspot activity
T03C10	4-03		Which of the following bands may provide long-distance communications via the ionosphere’s F region during the peak of the sunspot cycle?	6 and 10 meters
T03A04	4-05		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

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T03A09	4-05		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
T03B01	4-05		What is the relationship between the electric and magnetic fields of an electromagnetic wave?	They are at right angles
T03B02	4-05		What property of a radio wave defines its polarization?	The orientation of the electric field
T03B03	4-05		What are the two components of a radio wave?	Electric and magnetic fields
T09A11	4-07		What is antenna gain?	The increase in signal strength in a specified direction compared to a reference antenna
T05B09	4-08		Which decibel value most closely represents a power increase from 5 watts to 10 watts?	3 dB
T05B10	4-08		Which decibel value most closely represents a power decrease from 12 watts to 3 watts?	-6 dB
T05B11	4-08		Which decibel value represents a power increase from 20 watts to 200 watts?	10 dB
T07C07	4-09		What happens to power lost in a feed line?	It is converted into heat
T09B02	4-09		What is the most common impedance of coaxial cables used in amateur radio?	50 ohms
T09B03	4-09		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
T09B05	4-09		What happens as the frequency of a signal in coaxial cable is increased?	The loss increases
T09B12	4-09		What is standing wave ratio (SWR)?	A measure of how well a load is matched to a transmission line
T04A02	4-10		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
T07C04	4-10		What reading on an SWR meter indicates a perfect impedance match between the antenna and the feed line?	1:1
T07C05	4-10		Why do most solid-state transmitters reduce output power as SWR increases beyond a certain level?	To protect the output amplifier transistors
T07C06	4-10		What does an SWR reading of 4:1 indicate?	Impedance mismatch
T09B01	4-10		What is a benefit of low SWR?	Reduced signal loss
T09B09	4-10		What can cause erratic changes in SWR?	Loose connection in the antenna or feed line
T09A02	4-12		Which of the following describes a type of antenna loading?	Electrically lengthening by inserting inductors in radiating elements
T09A03	4-12		Which of the following describes a simple dipole oriented parallel to Earth's surface?	A horizontally polarized antenna
T09A04	4-12		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
T09A05	4-12		Which of the following increases the resonant frequency of a dipole antenna?	Shortening it
T09A07	4-12		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

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T09A08	4-12		What is the approximate length, in inches, of a quarter-wavelength vertical antenna for 146 MHz?	19
T09A09	4-12		What is the approximate length, in inches, of a half-wavelength 6 meter dipole antenna?	112
T09A10	4-12		In which direction does a half-wave dipole antenna radiate the strongest signal?	Broadside to the antenna
T09A12	4-12		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
T03A03	4-15		What antenna polarization is normally used for long-distance CW and SSB contacts on the VHF and UHF bands?	Horizontal
T03A05	4-15		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
T09A01	4-15		What is a beam antenna?	An antenna that concentrates signals in one direction
T09A06	4-15		Which of the following types of antenna offers the greatest gain?	Yagi
T07C09	4-17		Which of the following causes failure of coaxial cables?	Moisture contamination
T07C10	4-17		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
T07C11	4-17		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
T07D08	4-17		Which of the following types of solder should not be used for radio and electronic applications?	Acid-core solder
T07D09	4-17		What is the characteristic appearance of a cold tin-lead solder joint?	A rough or lumpy surface
T09B06	4-17		Which of the following RF connector types is most suitable for frequencies above 400 MHz?	Type N
T09B07	4-17		Which of the following is true of PL-259 type coax connectors?	They are commonly used at HF and VHF frequencies
T09B08	4-17		Which of the following is a source of loss in coaxial feed line?	All these choices are correct/1. Water intrusion into coaxial connectors/2. High SWR/3. Multiple connectors in the line
T09B10	4-17		What is the electrical difference between RG-58 and RG-213 coaxial cable?	RG-213 cable has less loss at a given frequency
T09B11	4-17		Which of the following types of feed line has the lowest loss at VHF and UHF?	Air-insulated hardline
T04A05	4-18		Where should an RF power meter be installed?	In the feed line, between the transmitter and antenna
T07C02	4-18		Which of the following is used to determine if an antenna is resonant at the desired operating frequency?	An antenna analyzer
T07C08	4-18		Which instrument can be used to determine SWR?	Directional wattmeter
T09B04	4-18		What is the major function of an antenna tuner (antenna coupler)?	It matches the antenna system impedance to the transceiver's output impedance

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T08D09	5-02		What is CW?	Another name for a Morse code transmission
T08A01	5-03		Which of the following is a form of amplitude modulation?	Single sideband
T08A02	5-04		What type of modulation is commonly used for VHF packet radio transmissions?	FM or PM
T08A03	5-04		Which type of voice mode is often used for long-distance (weak signal) contacts on the VHF and UHF bands?	SSB
T08A04	5-04		Which type of modulation is commonly used for VHF and UHF voice repeaters?	FM or PM
T08A05	5-04		Which of the following types of signal has the narrowest bandwidth?	CW
T08A06	5-04		Which sideband is normally used for 10 meter HF, VHF, and UHF single-sideband communications?	Upper sideband
T08A07	5-04		What is a characteristic of single sideband (SSB) compared to FM?	SSB signals have narrower bandwidth
T08A08	5-04		What is the approximate bandwidth of a typical single sideband (SSB) voice signal?	3 kHz
T08A09	5-04		What is the approximate bandwidth of a VHF repeater FM voice signal?	Between 10 and 15 kHz
T08A10	5-04		What is the approximate bandwidth of AM fast-scan TV transmissions?	About 6 MHz
T08A11	5-04		What is the approximate bandwidth required to transmit a CW signal?	150 Hz
T08A12	5-04		Which of the following is a disadvantage of FM compared with single sideband?	Only one signal can be received at a time
T04B02	5-05		Which of the following can be used to enter a transceiver's operating frequency?	The keypad or VFO knob
T04B04	5-05		What is a way to enable quick access to a favorite frequency or channel on your transceiver?	Store it in a memory channel
T01B09	5-07	[97.101 (a), 97.301(a-e)]	Why should you not set your transmit frequency to be exactly at the edge of an amateur band or sub-band?	All these choices are correct/1. To allow for calibration error in the transmitter frequency display/2. So that modulation sidebands do not extend beyond the band edge/3. To allow for transmitter frequency drift
T04A12	5-07		What is an electronic keyer?	A device that assists in manual sending of Morse code
T07A07	5-07		What is the function of a transceiver's PTT input?	Switches transceiver from receive to transmit when grounded
T07C01	5-07		What is the primary purpose of a dummy load?	To prevent transmitting signals over the air when making tests
T07C03	5-07		What does a dummy load consist of?	A non-inductive resistor mounted on a heat sink
T02B05	5-08		What would cause your FM transmission audio to be distorted on voice peaks?	You are talking too loudly
T02B13	5-08		What is the purpose of a squelch function?	Mute the receiver audio when a signal is not present
T04B01	5-08		What is the effect of excessive microphone gain	Distorted transmitted audio

			on SSB transmissions?	
T04B03	5-08		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
T07B01	5-08		What can you do if you are told your FM handheld or mobile transceiver is over-deviating?	Talk farther away from the microphone
T04B06	5-09		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 RIT or Clarifier (Receiver Incremental Tuning)
T04B08	5-09		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
T04B10	5-09		Which of the following receiver filter bandwidths provides the best signal-to-noise ratio for SSB reception?	2400 Hz
T04B12	5-09		What is the result of tuning an FM receiver above or below a signal's frequency?	Distortion of the signal's audio
T07A01	5-09		Which term describes the ability of a receiver to detect the presence of a signal?	Sensitivity
T07A04	5-09		Which term describes the ability of a receiver to discriminate between multiple signals?	Selectivity
T07A11	5-09		Where is an RF preamplifier installed?	Between the antenna and receiver
T07A09	5-10		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
T07A10	5-10		What device increases the transmitted output power from a transceiver?	An RF power amplifier
T07A06	5-11		What device converts the RF input and output of a transceiver to another band?	Transverter
T08D01	5-11		Which of the following is a digital communications mode?	All these choices are correct/1. Packet radio/2. IEEE 802.11/3. FT8
T08D08	5-12		Which of the following is included in packet radio transmissions?	All these choices are correct/1. A check sum that permits error detection/2. A header that contains the call sign of the station to which the information is being sent/3. Automatic repeat request in case of error
T08D10	5-12		Which of the following operating activities is supported by digital mode software in the WSJT-X software suite?	All these choices are correct/1. Earth-Moon-Earth/2. Weak signal propagation beacons/3. Meteor scatter
T08D11	5-12		What is an ARQ transmission system?	An error correction method in which the receiving station detects errors and sends a request for retransmission
T08D12	5-12		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
T08D13	5-12		What is FT8?	A digital mode capable of low signal-to-noise operation
T08D03	5-13		What kind of data can be transmitted by APRS?	All these choices are correct/1. GPS position data/2. Text messages/3. Weather data
T08D05	5-13		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
T08D06	5-13		What does the abbreviation "PSK" mean?	Phase Shift Keying

T04A04	5-14		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
T04A06	5-14		What signals are used in a computer-radio interface for digital mode operation?	Receive audio, transmit audio, and transmitter keying
T04A07	5-14		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
T08C11	5-15		What is an amateur radio station that connects other amateur stations to the internet?	A gateway
T04A01	5-16		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
T06D05	5-16		What type of circuit controls the amount of voltage from a power supply?	Regulator
T04A03	5-17		Why are short, heavy-gauge wires used for a transceiver’s DC power connection?	To minimize voltage drop when transmitting
T04A09	5-17		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
T04A11	5-17		Where should the negative power return of a mobile transceiver be connected in a vehicle?	At the 12 volt battery chassis ground
T06A10	5-17		Which of the following battery chemistries is rechargeable?	All these choices are correct/1. Nickel-metal hydride/2. Lithium-ion/3. Lead-acid
T06A11	5-17		Which of the following battery chemistries is not rechargeable?	Carbon-zinc
T10A10	5-17		What hazard is caused by charging or discharging a battery too quickly?	Overheating or out-gassing

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T01B10	6-01	[97.305(c)]	Where may SSB phone be used in amateur bands above 50 MHz?	In at least some segment of all these bands
T02A10	6-01		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
T02A11	6-01		What term describes an amateur station that is transmitting and receiving on the same frequency?	Simplex
T02A04	6-04		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
T02A09	6-04		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”
T07B10	6-04		What might be a problem if you receive a report that your audio signal through an FM repeater is distorted or unintelligible?	All these choices are correct/1. Your transmitter is slightly off frequency/2. Your batteries are running low/3. You are in a bad location
T02A02	6-06		What is the national calling frequency for FM simplex operations in the 2 meter band?	146.520 MHz
T02A05	6-06		How should you respond to a station calling CQ?	Transmit the other station’s call sign followed by your call sign
T02A08	6-06		What is the meaning of the procedural signal “CQ”?	Calling any station
T02A12	6-06		What should you do before calling CQ?	All these choices are correct/1. Listen first to be sure that no one else is using the frequency/2. Ask if the frequency is in use/3. Make sure you are authorized to use that frequency
T02B01	6-06		How is a VHF/UHF transceiver’s “reverse” function used?	To listen on a repeater’s input frequency
T02B09	6-06		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
T02B10	6-07		Which Q signal indicates that you are receiving interference from other stations?	QRM
T02B11	6-07		Which Q signal indicates that you are changing frequency?	QSY
T08C03	6-07		What operating activity involves contacting as many stations as possible during a specified period?	Contesting
T08C04	6-07		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
T08C05	6-08		What is a grid locator?	A letter-number designator assigned to a geographic location
T08D04	6-09		What type of transmission is indicated by the term "NTSC?"	An analog fast-scan color TV signal (National Television Standards Committee)
T04B05	6-10		What does the scanning function of an FM transceiver do?	Tunes through a range of frequencies to check for activity
T08C01	6-10		Which of the following methods is used to locate sources of noise interference or jamming?	Radio direction finding

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T08C02	6-10		Which of these items would be useful for a hidden transmitter hunt?	A directional antenna
T02A01	6-11		What is a common repeater frequency offset in the 2 meter band?	Plus or minus 600 kHz
T02A03	6-11		What is a common repeater frequency offset in the 70 cm band?	Plus or minus 5 MHz
T02A07	6-11		What is meant by "repeater offset”?	The difference between a repeater’s transmit and receive frequencies
T02B02	6-12		What term describes the use of a sub-audible tone transmitted along with normal voice audio to open the squelch of a receiver?	CTCSS (Continuous Tone Coded Squelch System)
T02B03	6-12		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
T02B04	6-12		Which of the following could be the reason you are unable to access a repeater whose output you can hear?	All these choices are correct/1. Improper transceiver offset/2. You are using the wrong CTCSS tone/3. You are using the wrong DCS code
T02B06	6-13		What type of signaling uses pairs of audio tones?	DTMF
T02B07	6-13		How can you join a digital repeater’s “talkgroup”?	Program your radio with the group’s ID or code
T02B12	6-13		What is the purpose of the color code used on DMR repeater systems?	Must match the repeater color code for access
T04A10	6-13		What function is performed with a transceiver and a digital mode hot spot?	Communication using digital voice or data systems via the internet
T04B07	6-13		What does a DMR “code plug” contain?	Access information for repeaters and talkgroups
T04B09	6-13		How is a specific group of stations selected on a digital voice transceiver?	By entering the group’s identification code
T04B11	6-13		Which of the following must be programmed into a D-STAR digital transceiver before transmitting?	Your call sign
T08C06	6-13		How is over the air access to IRLP nodes accomplished?	By using DTMF signals
T08C07	6-13		What is Voice Over Internet Protocol (VoIP)?	A method of delivering voice communications over the internet using digital techniques
T08C08	6-13		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)
T08C09	6-13		Which of the following protocols enables an amateur station to transmit through a repeater without using a radio to initiate the transmission?	EchoLink
T08C10	6-13		What is required before using the EchoLink system?	Register your call sign and provide proof of license
T08D02	6-14		What is a “talkgroup” on a DMR repeater?	A way for groups of users to share a channel at different times without hearing other users on the channel
T08D07	6-14		Which of the following describes DMR?	A technique for time-multiplexing two digital voice signals on a single 12.5 kHz repeater channel

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T02C02	6-16		Which of the following are typical duties of a Net Control Station?	Call the net to order and direct communications between stations checking in
T02C05	6-16		What does the term “traffic” refer to in net operation?	Messages exchanged by net stations
T02C07	6-16		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
T02C03	6-17		What technique is used to ensure that voice messages containing unusual words are received correctly?	Spell the words using a standard phonetic alphabet
T02C08	6-17		Which of the following is a characteristic of good traffic handling?	Passing messages exactly as received
T02C10	6-17		What information is contained in the preamble of a formal traffic message?	Information needed to track the message
T02C11	6-17		What is meant by “check” in a radiogram header?	The number of words or word equivalents in the text portion of the message
T01A10	6-18	[97.3(a)(38),97.407]	What is the Radio Amateur Civil Emergency Service (RACES)?	All these choices are correct/1. A radio service using amateur frequencies for emergency management or civil defense communications/2. A radio service using amateur stations for emergency management or civil defense communications/3. An emergency service using amateur operators certified by a civil defense organization as being enrolled in that organization
T02C04	6-18		What is RACES? (Radio Amateur Civil Emergency Service)	An FCC part 97 amateur radio service for civil defense communications during national emergencies
T02C06	6-18		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
T02C01	6-19	[97.103(a)]	When do FCC rules NOT apply to the operation of an amateur station?	FCC rules always apply
T02C09	6-19		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
T01B02	6-22	[97.301, 97.207(c)]	Which amateurs may contact the International Space Station (ISS) on VHF bands?	Any amateur holding a Technician class or higher license
T01A07	6-23	[97.3(a)(41)]	What is the FCC Part 97 definition of a space station?	An amateur station located more than 50 km above Earth's surface
T01E02	6-23	[97.301, 97.207(c)]	Who may be the control operator of a station communicating through an amateur satellite or space station?	Any amateur allowed to transmit on the satellite uplink frequency
T08B05	6-23		What is a satellite beacon?	A transmission from a satellite that contains status information

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T08B07	6-23		What is Doppler shift in reference to satellite communications?	An observed change in signal frequency caused by relative motion between the satellite and Earth station
T08B09	6-23		What causes spin fading of satellite signals?	Rotation of the satellite and its antennas
T08B10	6-23		What is a LEO satellite?	A satellite in low earth orbit
T08B01	6-24		What telemetry information is typically transmitted by satellite beacons?	Health and status of the satellite
T08B02	6-24		What is the impact of using excessive effective radiated power on a satellite uplink?	Blocking access by other users
T08B03	6-24		Which of the following are provided by satellite tracking programs?	All these choices are correct/1. Maps showing the real-time position of the satellite track over Earth/2. The time, azimuth, and elevation of the start, maximum altitude, and end of a pass/3. The apparent frequency of the satellite transmission, including effects of Doppler shift
T08B04	6-24		What mode of transmission is commonly used by amateur radio satellites?	All these choices are correct/1. SSB/2. FM/3. CW/data
T08B06	6-24		Which of the following are inputs to a satellite tracking program?	The Keplerian elements
T08B08	6-24		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
T08B11	6-24		Who may receive telemetry from a space station?	Anyone
T08B12	6-24		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

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T01A02	7-01	[97.1]	Which agency regulates and enforces the rules for the Amateur Radio Service in the United States?	The FCC
T01A01	7-02	[97.1]	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
T01A04	7-03	[97.5(b)(1)]	How many operator/primary station license grants may be held by any one person?	One
T01C01	7-03	[97.9(a), 97.17(a)]	For which license classes are new licenses currently available from the FCC?	Technician, General, Amateur Extra
T01F11	7-03	[97.5(b)(2)]	Which of the following is a requirement for the issuance of a club station license grant?	The club must have at least four members
T01A05	7-05	[97.7]	What proves that the FCC has issued an operator/primary license grant?	The license appears in the FCC ULS database
T01C08	7-05	[97.25]	What is the normal term for an FCC-issued amateur radio license?	Ten years
T01C09	7-05	[97.21(a)(b)]	What is the grace period for renewal if an amateur license expires?	Two years
T01C10	7-05	[97.5a]	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
T01C11	7-05	[97.21(b)]	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
T01C04	7-08	[97.23]	What may happen if the FCC is unable to reach you by email?	Revocation of the station license or suspension of the operator license
T01C07	7-08	[97.23]	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
T01F01	7-08	[97.103(c)]	When must the station and its records be available for FCC inspection?	At any time upon request by an FCC representative
T01B01	7-09	[97.301(e)]	Which of the following frequency ranges are available for phone operation by Technician licensees?	28.300 MHz to 28.500 MHz
T01B03	7-09	[97.301(a)]	Which frequency is in the 6 meter amateur band?	52.525 MHz
T01B04	7-09	[97.301(a)]	Which amateur band includes 146.52 MHz?	2 meters
T01B06	7-09	[97.301(e), 97.305]	On which HF bands does a Technician class operator have phone privileges?	10 meter band only
T01A06	7-11	[97.3(a)(9)]	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
T01B05	7-11	[97.305(c)]	How may amateurs use the 219 to 220 MHz segment of 1.25 meter band?	Fixed digital message forwarding systems only
T01B07	7-11	[97.305(a), (c)]	Which of the following VHF/UHF band segments are limited to CW only?	50.0 MHz to 50.1 MHz and 144.0 MHz to 144.1 MHz

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T01B11	7-12	[97.313]	What is the maximum peak envelope power output for Technician class operators in their HF band segments?	200 watts
T01B12	7-12	[97.313 (b)]	Except for some specific restrictions, what is the maximum peak envelope power output for Technician class operators using frequencies above 30 MHz?	1500 watts
T01A08	7-13	[97.3(a) (22)]	Which of the following entities recommends transmit/receive channels and other parameters for auxiliary and repeater stations?	Volunteer Frequency Coordinator recognized by local amateurs
T01A09	7-13	[97.3(a) (22)]	Who selects a Frequency Coordinator?	Amateur operators in a local or regional area whose stations are eligible to be repeater or auxiliary stations
T01B08	7-13	[97.303]	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 segments, and must avoid interfering with them
T01C03	7-15	[97.117]	What types of international communications are 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
T01C06	7-15	[97.5(a) (2)]	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
T01D01	7-15	[97.111 (a)(1)]	With which countries are FCC-licensed amateur radio stations prohibited from exchanging communications?	Any country whose administration has notified the International Telecommunication Union (ITU) that it objects to such communications
T01C02	7-17	[97.19]	Who may select a desired call sign under the vanity call sign rules?	Any licensed amateur
T01C05	7-17		Which of the following is a valid Technician class call sign format?	KF1XXX

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T01E01	8-01	[97.7(a)]	When may an amateur station transmit without a control operator?	Never
T01E03	8-01	[97.103 (b)]	Who must designate the station control operator?	The station licensee
T01E05	8-01	[97.3(a) (14)]	What is an amateur station's control point?	The location at which the control operator function is performed
T01E04	8-02	[97.103 (b)]	What determines the transmitting frequency privileges of an amateur station?	The class of operator license held by the control operator
T01E06	8-02	[97.301]	When, under normal circumstances, may a Technician class licensee be the control operator of a station operating in an Amateur Extra Class band segment?	At no time
T01E07	8-02	[97.103 (a)]	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
T01E11	8-02	[97.103 (a)]	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
T01A03	8-03	[97.119 (b)(2)]	What do the FCC rules state regarding the use of a phonetic alphabet for station identification in the Amateur Radio Service?	It is encouraged
T01D11	8-03	[97.119 (a)]	When may an amateur station transmit without identifying on the air?	When transmitting signals to control model craft
T01F03	8-03	[97.119 (a)]	When are you required to transmit your assigned call sign?	At least every 10 minutes during and at the end of a communication
T01F04	8-03	[97.119 (b)(2)]	What language may you use for identification when operating in a phone sub-band?	English
T01F05	8-03	[97.119 (b)(2)]	What method of call sign identification is required for a station transmitting phone signals?	Send the call sign using a CW or phone emission
T01F02	8-04	[97.119 (a)]	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
T01F06	8-04	[97.119 (c)]	Which of the following self-assigned indicators are acceptable when using a phone transmission?	All these choices are correct/1. KL7CC stroke W3/2. KL7CC slant W3/3. KL7CC slash W3
T01A11	8-05	[97.101 (d)]	When is willful interference to other amateur radio stations permitted?	At no time
T02A06	8-05		Which of the following is required when making on-the-air test transmissions?	Identify the transmitting station
T02B08	8-05		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
T01F07	8-07	[97.115 (a)(2)]	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
T01F08	8-07	[97.3(a) (47)]	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

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T01E08	8-09	[97.3(a)(6), 97.205(d)]	Which of the following is an example of automatic control?	Repeater operation
T01E09	8-09	[97.109(c)]	Which of the following are required for remote control operation?	All these choices are correct/1. The control operator must be at the control point/2. A control operator is required at all times/3. The control operator must indirectly manipulate the controls
T01E10	8-09	[97.3(a)(39)]	Which of the following is an example of remote control as defined in Part 97?	Operating the station over the internet
T01F10	8-09	[97.205(g)]	Who is accountable if a repeater inadvertently retransmits communications that violate the FCC rules?	The control operator of the originating station
T01D05	8-10	[97.113(a)(3)(ii)]	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
T01D06	8-10	[97.113(a)(4)]	What, if any, are the restrictions concerning transmission of language that may be considered indecent or obscene?	Any such language is prohibited
T01D08	8-10	[97.113(a)(3)(iii)]	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
T01D02	8-11	[97.113(b), 97.111(b)]	Under which of the following circumstances are one-way transmissions by an amateur station prohibited?	Broadcasting
T01D03	8-11	[97.211(b), 97.215(b), 97.113(a)(4)]	When is it permissible to transmit messages encoded to obscure their meaning?	Only when transmitting control commands to space stations or radio control craft
T01D04	8-11	[97.113(a)(4), 97.113(c)]	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
T01D07	8-11	[97.113(d)]	What types of amateur stations can automatically retransmit the signals of other amateur stations?	Repeater, auxiliary, or space stations
T01D09	8-11	[97.113(5)(b)]	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
T01D10	8-11	[97.3(a)(10)]	How does the FCC define broadcasting for the Amateur Radio Service?	Transmissions intended for reception by the general public

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T10A01	9-02		Which of the following is a safety hazard of a 12-volt storage battery?	Shorting the terminals can cause burns, fire, or an explosion
T10A02	9-02		What health hazard is presented by electrical current flowing through the body?	All these choices are correct/1. It may cause injury by heating tissue/2. It may disrupt the electrical functions of cells/3. It may cause involuntary muscle contractions
T10A11	9-02		What hazard exists in a power supply immediately after turning it off?	Charge stored in filter capacitors
T10A03	9-04		In the United States, what circuit does black wire insulation indicate in a three-wire 120 V cable?	Hot
T10A06	9-04		What is a good way to guard against electrical shock at your station?	All these choices are correct/1. Use three-wire cords and plugs for all AC powered equipment/2. Connect all AC powered station equipment to a common safety ground/3. Install mechanical interlocks in high-voltage circuits
T10A08	9-04		Where should a fuse or circuit breaker be installed in a 120V AC power circuit?	In series with the hot conductor only
T10A07	9-05		Where should a lightning arrester be installed in a coaxial feed line?	On a grounded panel near where feed lines enter the building
T10A09	9-05		What should be done to all external ground rods or earth connections?	Bond them together with heavy wire or conductive strap
T10B01	9-05		Which of the following is good practice when installing ground wires on a tower for lightning protection?	Ensure that connections are short and direct
T10B10	9-05		Which of the following is true when installing grounding conductors used for lightning protection?	Sharp bends must be avoided
T10B11	9-05		Which of the following establishes grounding requirements for an amateur radio tower or antenna?	Local electrical codes
T04A08	9-06		Which of the following conductors is preferred for bonding at RF?	Flat copper strap
T07B11	9-06		What is a symptom of RF feedback in a transmitter or transceiver?	Reports of garbled, distorted, or unintelligible voice transmissions
T07B04	9-07		Which of the following could you use to cure distorted audio caused by RF current on the shield of a microphone cable?	Ferrite choke
T07B02	9-08		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
T07B03	9-08		Which of the following can cause radio frequency interference?	All these choices are correct/1. Fundamental overload/2. Harmonics/3. Spurious emissions
T07B05	9-08		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
T07B07	9-08		Which of the following can reduce overload of a VHF transceiver by a nearby commercial FM station?	Installing a band-reject filter

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T06D03	9-09		Which of the following is a reason to use shielded wire?	To prevent coupling of unwanted signals to or from the wire
T07B06	9-09		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
T07B08	9-10		What should you do if something in a neighbor's home is causing harmful interference to your amateur station?	All these choices are correct/1. Work with your neighbor to identify the offending device/2. Politely inform your neighbor that FCC rules prohibit the use of devices that cause interference/3. Make sure your station meets the standards of good amateur practice
T07B09	9-10		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
T10C01	9-11		What type of radiation are radio signals?	Non-ionizing radiation
T10C05	9-11		Why do exposure limits vary with frequency?	The human body absorbs more RF energy at some frequencies than at others
T10C07	9-11		What hazard is created by touching an antenna during a transmission?	RF burn to skin
T10C12	9-11		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
T10C13	9-11		Who is responsible for ensuring that no person is exposed to RF energy above the FCC exposure limits?	The station licensee
T10C02	9-12		At which of the following frequencies does maximum permissible exposure have the lowest value?	50 MHz
T10C03	9-13		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
T10C10	9-13		Why is duty cycle one of the factors used to determine safe RF radiation exposure levels?	It affects the average exposure to radiation
T10C11	9-13		What is the definition of duty cycle during the averaging time for RF exposure?	The percentage of time that a transmitter is transmitting
T10C04	9-14		What factors affect the RF exposure of people near an amateur station antenna?	All these choices are correct/1. Frequency and power level of the RF field/2. Distance from the antenna to a person/3. Radiation pattern of the antenna
T10C06	9-14		Which of the following is an acceptable method to determine whether your station complies with FCC RF exposure regulations?	All these choices are correct/1. By calculation based on FCC OET Bulletin 65/2. By calculation based on computer modeling/3. By measurement of field strength using calibrated equipment
T10C08	9-14		Which of the following actions can reduce exposure to RF radiation?	Relocate antennas

2022-2026 Technician Class
FCC Element 2 Question Pool
Effective 7/01/2022 – 6/30/2026

Exam	Page	Rule	Question	Answer
T10C09	9-14		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
T10B04	9-17		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
T10B05	9-17		What is the purpose of a safety wire through a turnbuckle used to tension guy lines?	Prevent loosening of the turnbuckle from vibration
T10B06	9-17		What is the minimum safe distance from a power line to allow when installing an antenna?	Enough so that if the antenna falls, no part of it can come closer than 10 feet to the power wires
T10B08	9-17		Which is a proper grounding method for a tower?	Separate eight-foot ground rods for each tower leg, bonded to the tower and each other
T10B09	9-17		Why should you avoid attaching an antenna to a utility pole?	The antenna could contact high-voltage power lines
T10B02	9-19		What is required when climbing an antenna tower?	All these choices are correct/1. Have sufficient training on safe tower climbing techniques/2. Use appropriate tie-off to the tower at all times/3. Always wear an approved climbing harness
T10B03	9-19		Under what circumstances is it safe to climb a tower without a helper or observer?	Never
T10B07	9-19		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