
Lesson 10: Repeaters

Preparation for
Amateur Radio
Technician Class
Exam

Topics

- Repeaters
- Finding a repeater
- Repeater operations
- Autopatch
- Courtesy
- Frequency coordination
- Exam questions for Lesson 10

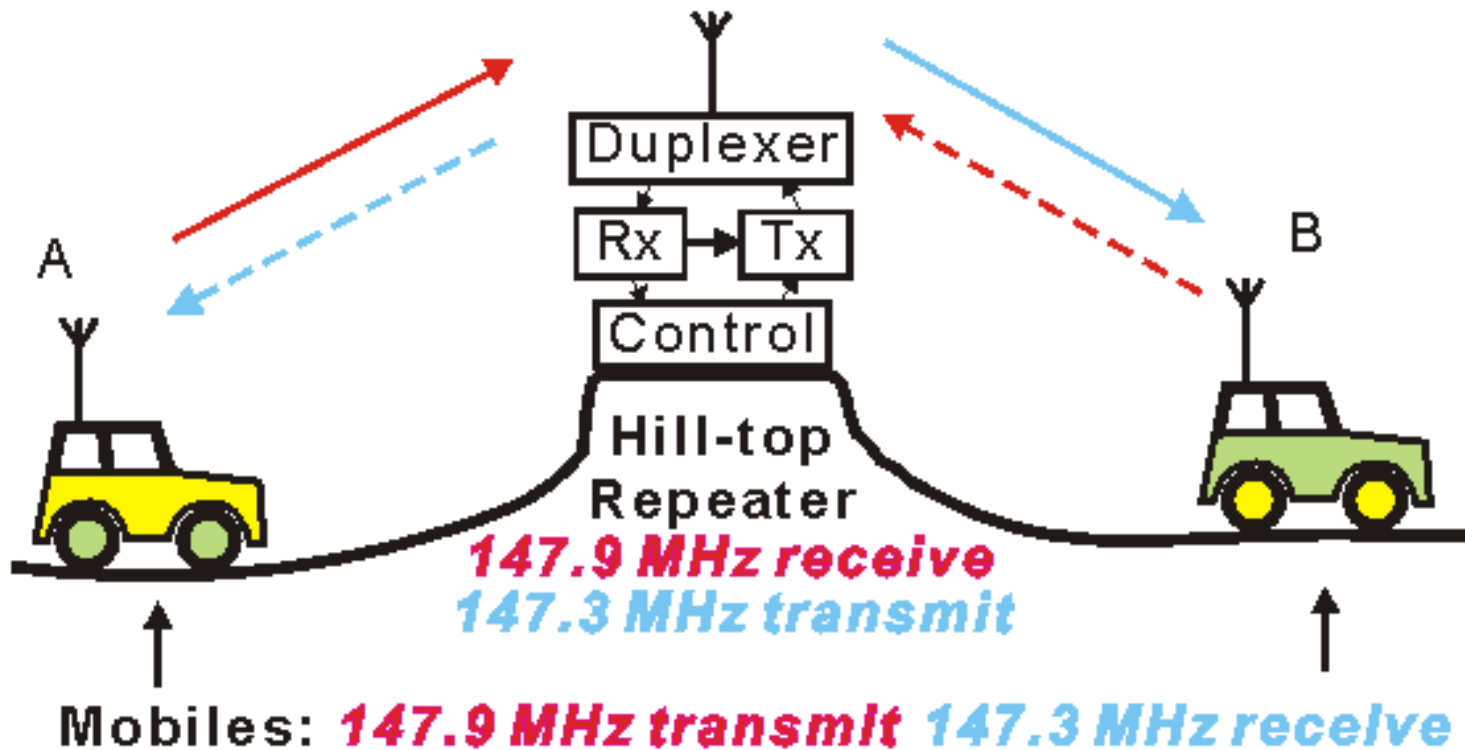
What is a repeater

- A *repeater* is a device that receives a signal on one frequency and retransmits (repeats) it on another frequency
 - The frequency it receives on is the *input frequency*
 - The frequency it transmits on is the *output frequency*
- The difference between the input and output frequencies is the *offset* or *split*

Why a repeater is needed

- Repeater are needed for a variety of reasons:
 - Extend the communication range in the VHF and UHF bands, particularly for low-power handheld and mobile radios
 - Allow communication between areas separated by barriers such as mountains
 - Provide an on-air meeting place for members of a club or group who are too far apart for simplex communication

How a Repeater Works



Components of a Receiver

- Duplexer
- Controller
- Transmitter
- Receiver
- Antenna

Components of a Repeater



Using a Repeater

- To use a repeater, you need its input frequency and offset
- The standard offset for 2 meter repeaters is 600 kHz
- The standard offset for 70 cm repeaters is 5 MHz

Using a Repeater

- You must transmit your call sign at the end of contact and at least every 10 minutes during the contact
 - Never transmit without identifying
- A repeater must also identify itself periodically
 - Many repeaters use Morse Code for this purpose



Who owns a Repeater?

- Typically a club or an individual owns a repeater and pays for its maintenance and upkeep
- Most repeaters are open
 - Anyone can use them
- Some repeaters are closed or private
 - You must ask the control operator their requirements for using the repeater
 - You may need to join a club or pay some usage fee to use a closed repeater

CTCSS/PL

- These are subaudible tone-controlled squelch, a burst of tones that give access to the repeater
 - CTCSS = continuous tone-coded squelch system
 - PL = Private Line (a Motorola trademark)
- Using CTCSS to access a repeater prevents interference by extraneous transmissions, maybe from other antennas sharing the same site

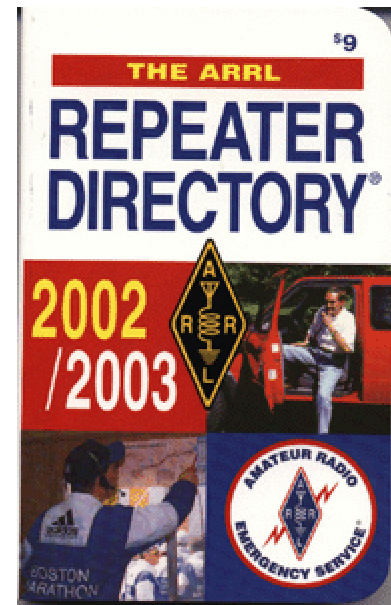
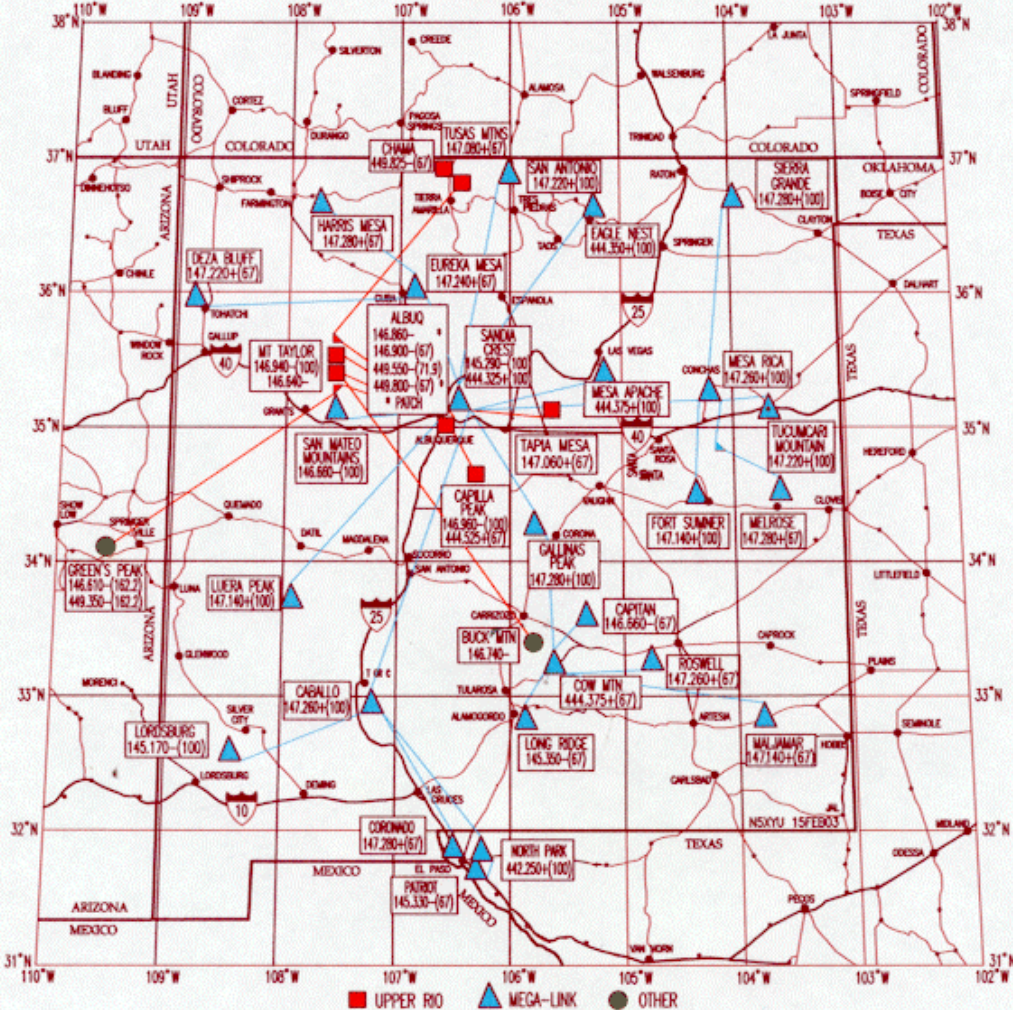
Cross-band Repeaters

- Cross-band repeaters receive on one band and transmit on another band
 - Many dual-band HTs can be set up to perform as a cross-band repeater

Finding a Repeater

UPPER RIO FM SOCIETY, INC LINKING SYSTEM COVERAGE

FEBRUARY 2003



Calling Courtesy

- Call someone else on the repeater by saying their call sign and then your call sign
- Keep conversations short to allow other people to use the repeater
- Acknowledge other stations and allow them to join the conversation or make their own call
- If you are in a conversation, pause before responding to allow others to break in

Calling Courtesy

- Be especially courteous during rush hour, when many people want to use the repeater, and there may be people needing to use the radio to report problems such as accidents
- Avoid third party communication nets during rush hour – schedule them for another time
- If you need to break into a conversation, say your call sign during a break between transmissions

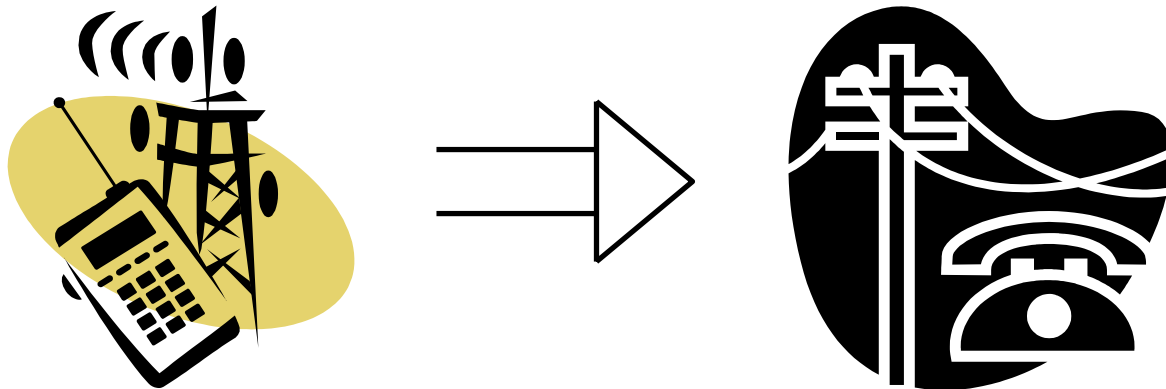
Courtesy Tones

- A repeater may have a *courtesy tone* that sounds 1 or 2 seconds after each transmission – you may transmit after the beep
- A repeater uses a *time-out timer* to keep transmissions short
 - After some amount of time of continuous transmission the repeater shuts down for a few minutes



Autopatch

- An *autopatch* is a device on the repeater that allows you to make telephone calls through the repeater using an access code provided by the owner of the repeater



Autopatch

- You should NOT use the autopatch:
 - When a telephone is available
 - For business calls
 - To avoid a toll call

Autopatch

- You should use the autopatch in an emergency when no telephone is available
 - For example to call for an ambulance or tow truck for an automobile accident when no one has a cell phone available



Frequency Coordination

- *Frequency coordinators* make sure that new repeaters use frequencies that do not interfere with other repeaters in the area
 - They assign a specific receive/transmit pair of frequencies for each repeater in the area
- Repeaters in the same area using the same or similar frequencies can interfere with each other
 - When two repeaters that have been recommended by a frequency coordinator interfere with each other, it is the responsibility of both repeater licensees to resolve interference problems

Simplex

- This is when stations are talking to each other directly, not using a repeater
 - Transmit and receive frequencies are the same
- Listen to the repeater input frequency
 - If you can receive the other station on that frequency, then you will be able to communicate by simplex
- Use simplex to communicate when you can
 - It avoids tying up the repeater, and you will generally have more privacy for your conversations

Amateur Satellite

- Any licensed amateur radio operator can make use of an amateur satellite for communications
- Satellites are normally in an elliptical path around the earth
 - The closest point to the earth is the perigee
 - The farthest point from the earth is the apogee
 - The satellite's location from a point on earth is calculated using Keplerian elements
 - VHF/UHF bands pass easily through the ionosphere, making them good bands to use when bouncing signals off a satellite

Amateur Satellite

- Communication through a satellite is line-of-sight
 - You need to point your antenna to the satellite to bounce the signal off the satellite to another station
 - The lowest power requirement is when the satellite is right overhead of your antenna
 - That is also the point where your signal will travel the least distance, basically straight up and straight down!
- There isn't much time to communicate with a satellite
 - Line-of-sight to the International Space Station lasts typically 4-6 minutes for any particular earth station

Amateur Satellite

➤ Doppler effect

- The frequency of the signal transmitted from the satellite moving toward you appears to shift higher
- The frequency of the signal transmitted from the satellite moving away from you appears to shift lower
- You have to change the frequency on your receiver to match the satellite as it moves

EME or Moonbounce

- This is a long distance
 - There is a lot of signal loss
 - Signals are weak – most EME stations use CW for this reason
 - Requires high power station and high gain antenna
- Good choices for EME (Earth-Moon-Earth) antennas:
 - A parabolic-dish antenna
 - A multi-element array of collinear antennas
 - A high-gain array of Yagi antennas
- A ground-plane antenna is a bad choice because of its relatively low gain

Amateur Television

- Same as broadcast television, but in the amateur bands
- Typically transmitted using AM double sideband transmitter and a video source such as a camera or VCR
- A cable-ready TV set with a good outdoor antenna can receive local ATV activity

Slow-Scan Television

- Transmission of still pictures over the radio
- Popular on 20 meter HF using SSB and VHF/UHF with FM radios
- It can take up to 2 minutes to transmit a color picture using SSTV
 - Ask a repeater operator before using a repeater for this purpose!

Beacons

- One kind of station that is permitted one-way communication on the amateur bands
- A beacon is an amateur station that transmits communications for the purposes of observation of propagation and reception
 - Mainly to allow amateurs to tell when a band is open to different parts of the country or the world
- A beacon is allowed to be automatically controlled in certain band segments and the transmitter power must be 100 watts or below

Telecommand

- The other kind of station that is permitted one-way communication on the amateur bands
 - This is a one way transmission to initiate, modify or terminate functions of a device at a distance
 - You must identify the transmitter with your call sign, name and address
 - You must control the remote device with a wire line or radio control link
 - You must protect the system so that only authorized transmissions under the control of a control operator can be made
 - A photocopy of the station license must be posted in a conspicuous location

Exam Questions

- The following slides contain questions from the exam pool that are covered in this section of the notes

T9A01

- T9A01 What is the purpose of repeater operation?
- A. To cut your power bill by using someone else's higher power system
 - B. To help mobile and low-power stations extend their usable range
 - C. To transmit signals for observing propagation and reception
 - D. To communicate with stations in services other than amateur

T9A05

- T9A05 When using a repeater to communicate, which of the following do you need to know about the repeater?
- A. Its input frequency and offset
 - B. Its call sign
 - C. Its power level
 - D. Whether or not it has an autopatch

T9A09

- T9A09 What is the usual input/output frequency separation for repeaters in the 2-meter band?
- A. 600 kHz
 - B. 1.0 MHz
 - C. 1.6 MHz
 - D. 5.0 MHz

T9A10

- T9A10 (D) What is the usual input/output frequency separation for repeaters in the 70-centimeter band?
- A. 600 kHz
 - B. 1.0 MHz
 - C. 1.6 MHz
 - D. 5.0 MHz

T9A11

- T9A11 What does it mean to say that a repeater has an input and an output frequency?
- A. The repeater receives on one frequency and transmits on another
 - B. The repeater offers a choice of operating frequency, in case one is busy
 - C. One frequency is used to control the repeater and another is used to retransmit received signals
 - D. The repeater must receive an access code on one frequency before retransmitting received signals

T9A12

- T9A12 What is the most likely reason you might hear Morse code tones on a repeater frequency?
- A. Intermodulation
 - B. An emergency request for help
 - C. The repeater's identification
 - D. A courtesy tone

T9A18

- T9A18 What should you do if you hear a closed repeater system that you would like to be able to use?
- A. Contact the control operator and ask to join
 - B. Use the repeater until told not to
 - C. Use simplex on the repeater input until told not to
 - D. Write the FCC and report the closed condition

T9A19

- T9A19 Who pays for the site rental and upkeep of most repeaters?
- A. All amateurs, because part of the amateur license examination fee is used
 - B. The repeater owner and donations from its users
 - C. The Federal Communications Commission
 - D. The federal government, using money granted by Congress

T9B19

- T9B19 What is a continuous tone-coded squelch system (CTCSS) tone (sometimes called PL -- a Motorola trademark)?
- A. A special signal used for telecommand control of model craft
 - B. A sub-audible tone, added to a carrier, which may cause a receiver to accept the signal
 - C. A tone used by repeaters to mark the end of a transmission
 - D. A special signal used for telemetry between amateur space stations and Earth stations

T9B20

- T9B20 What does it mean if you are told that a tone is required to access a repeater?
- A. You must use keypad tones like your phone system to operate it
 - B. You must wait to hear a warbling two-tone signal to operate it
 - C. You must wait to hear a courtesy beep tone at the end of another's transmission before you can operate it
 - D. You must use a subaudible tone-coded squelch with your signal to operate it

T9B21

- T9B21 What is the term that describes a repeater that receives signals on one band and retransmits them on another band?
- A. A special coordinated repeater
 - B. An illegally operating repeater
 - C. An auxiliary station
 - D. A crossband repeater

T6A04

- T6A04 How do you call another station on a repeater if you know the station's call sign?
- A. Say "break, break 79," then say the station's call sign
 - B. Say the station's call sign, then identify your own station
 - C. Say "CQ" three times, then say the station's call sign
 - D. Wait for the station to call "CQ," then answer it

T9A02

- T9A02 What is a courtesy tone, as used in repeater operations?
- A. A sound used to identify the repeater
 - B. A sound used to indicate when a transmission is complete
 - C. A sound used to indicate that a message is waiting for someone
 - D. A sound used to activate a receiver in case of severe weather

T9A03

- T9A03 During commuting rush hours, which type of repeater operation should be discouraged?
- A. Mobile stations
 - B. Low-power stations
 - C. Highway traffic information nets
 - D. Third-party communications nets

T9A04

- T9A04 Which of the following is a proper way to break into a conversation on a repeater?
- A. Wait for the end of a transmission and start calling the desired party
 - B. Shout, "break, break!" to show that you're eager to join the conversation
 - C. Turn on an amplifier and override whoever is talking
 - D. Say your call sign during a break between transmissions

T9A06

- T9A06 Why should you pause briefly between transmissions when using a repeater?
- A. To check the SWR of the repeater
 - B. To reach for pencil and paper for third-party communications
 - C. To listen for anyone wanting to break in
 - D. To dial up the repeater's autopatch

T9A07

- T9A07 Why should you keep transmissions short when using a repeater?
- A. A long transmission may prevent someone with an emergency from using the repeater
 - B. To see if the receiving station operator is still awake
 - C. To give any listening non-hams a chance to respond
 - D. To keep long-distance charges down

T9A17

- T9A17 (D) What is the purpose of a repeater time-out timer?
- A. It lets a repeater have a rest period after heavy use
 - B. It logs repeater transmit time to predict when a repeater will fail
 - C. It tells how long someone has been using a repeater
 - D. It limits the amount of time a repeater can transmit continuously

T9A08

- T9A08 How could you determine if a repeater is already being used by other stations?
- A. Ask if the frequency is in use, then give your call sign
 - B. If you don't hear anyone, assume that the frequency is clear to use
 - C. Check for the presence of the CTCSS tone
 - D. If the repeater identifies when you key your transmitter, it probably was already in use

T9A16

- T9A16 What is it called if the frequency coordinator recommends that you operate on a specific repeater frequency pair?
- A. FCC type acceptance
 - B. FCC type approval
 - C. Frequency division multiplexing
 - D. Repeater frequency coordination

T9A20

- T9A20 If a repeater is causing harmful interference to another amateur repeater and a frequency coordinator has recommended the operation of both repeaters, who is responsible for resolving the interference?
- A. The licensee of the repeater that has been recommended for the longest period of time
 - B. The licensee of the repeater that has been recommended the most recently
 - C. The frequency coordinator
 - D. Both repeater licensees

T9B13

➤ T9B13 What is an autopatch?

- A. An automatic digital connection between a US and a foreign amateur
- B. A digital connection used to transfer data between a hand-held radio and a computer
- C. A device that allows radio users to access the public telephone system
- D. A video interface allowing images to be patched into a digital data stream

T9B14

- T9B14 Which of the following statements about Amateur Radio autopatch usage is true?
- A. The person called using the autopatch must be a licensed radio amateur
 - B. The autopatch will allow only local calls to police, fire and ambulance services
 - C. Communication through the autopatch is not private
 - D. The autopatch should not be used for reporting emergencies

T9A13

- T9A13 What is the common amateur meaning of the term "simplex operation"?
- A. Transmitting and receiving on the same frequency
 - B. Transmitting and receiving over a wide area
 - C. Transmitting on one frequency and receiving on another
 - D. Transmitting one-way communications

T9A14

- T9A14 When should you use simplex operation instead of a repeater?
- A. When the most reliable communications are needed
 - B. When a contact is possible without using a repeater
 - C. When an emergency telephone call is needed
 - D. When you are traveling and need some local information

T9A15

- T9A15 If you are talking to a station using a repeater, how would you find out if you could communicate using simplex instead?
- A. See if you can clearly receive the station on the repeater's input frequency
 - B. See if you can clearly receive the station on a lower frequency band
 - C. See if you can clearly receive a more distant repeater
 - D. See if a third station can clearly receive both of you

T9B03

- T9B03 The control operator of a station communicating through an amateur satellite must hold what class of license?
- A. Amateur Extra or Advanced
 - B. Any class except Novice
 - C. Any class
 - D. Technician with satellite endorsement

T9B04

- T9B04 How does the Doppler effect change an amateur satellite's signal as the satellite passes overhead?
- A. The signal's amplitude increases or decreases
 - B. The signal's frequency increases or decreases
 - C. The signal's polarization changes from horizontal to vertical
 - D. The signal's circular polarization rotates

T9B05

- T9B05 Why do many amateur satellites operate on the VHF/UHF bands?
- A. To take advantage of the skip zone
 - B. Because VHF/UHF equipment costs less than HF equipment
 - C. To give Technician class operators greater access to modern communications technology
 - D. Because VHF and UHF signals easily pass through the ionosphere

T9B06

- T9B06 Which antenna system would NOT be a good choice for an EME (moonbounce) station?
- A. A parabolic-dish antenna
 - B. A multi-element array of collinear antennas
 - C. A ground-plane antenna
 - D. A high-gain array of Yagi antennas

T9B07

- T9B07 What does the term "apogee" refer to when applied to an Earth satellite?
- A. The closest point to the Earth in the satellite's orbit
 - B. The most distant point from the Earth in the satellite's orbit
 - C. The point where the satellite appears to cross the equator
 - D. The point when the Earth eclipses the satellite from the sun

T9B08

- T9B08 What does the term "perigee" refer to when applied to an Earth satellite?
- A. The closest point to the Earth in the satellite's orbit
 - B. The most distant point from the Earth in the satellite's orbit
 - C. The time when the satellite will be on the opposite side of the Earth
 - D. The effect that causes the satellite's signal frequency to change

T9B09

- T9B09 What mathematical parameters describe a satellite's orbit?
- A. Its telemetry data
 - B. Its Doppler shift characteristics
 - C. Its mean motion
 - D. Its Keplerian elements

T9B10

- T9B10 What is the typical amount of time an amateur has to communicate with the International Space Station?
- A. 4 to 6 minutes per pass
 - B. An hour or two per pass
 - C. About 20 minutes per pass
 - D. All day

T9B11

- T9B11 Which of the following would be the best emission mode for two-way EME contacts?
- A. CW
 - B. AM
 - C. FM
 - D. Spread spectrum

T9B15

- T9B15 Which of the following will allow you to monitor Amateur Television (ATV) on the 70-cm band?
- A. A portable video camera
 - B. A cable ready TV receiver
 - C. An SSTV converter
 - D. A TV flyback transformer

T9B16

- T9B16 When may slow-scan television be transmitted through a 2-meter repeater?
- A. At any time, providing the repeater control operator authorizes this unique transmission
 - B. Never; slow-scan television is not allowed on 2 meters
 - C. Only after 5:00 PM local time
 - D. Never; slow-scan television is not allowed on repeaters

T9B01

- T9B01 What is an amateur station called that transmits communications for the purpose of observation of propagation and reception?
- A. A beacon
 - B. A repeater
 - C. An auxiliary station
 - D. A radio control station

T9B02

- T9B02 Which of the following is true of amateur radio beacon stations?
- A. Automatic control is allowed in certain band segments
 - B. One-way transmissions are permitted
 - C. Maximum output power is 100 watts
 - D. All of these choices are correct

T9B12

- T9B12 What minimum information must be on a label affixed to a transmitter used for telecommand (control) of model craft?
- A. Station call sign
 - B. Station call sign and the station licensee's name
 - C. Station call sign and the station licensee's name and address
 - D. Station call sign and the station licensee's class of license

T9B17

- T9B17 What is the definition of telecommand?
- A. All communications using the telephone or telegraphy with space stations
 - B. A one way transmission to initiate conversation with astronauts aboard a satellite or space station
 - C. A one way transmission to initiate, modify or terminate functions of a device at a distance
 - D. Two way transmissions to initiate, modify or terminate functions of a device at a distance

T9B18

- T9B18 What provisions must be in place for the legal operation of a telecommand station?
- A. The station must have a wire line or radio control link B.
 - A photocopy of the station license must be posted in a conspicuous location
 - C. The station must be protected so that no unauthorized transmission can be made
 - D. All of these choices are correct