Study Guide

Technician Class Amateur Radio License

July 1, 2022 to June 31, 2026

Ver 2.0

Technician Class Study Guide

This guide is not designed to teach you electrical theory or antenna theory. It is meant to give each question some meaning so you understand the relationship between the question and the answer. Anyone can memorize the answers given enough time. I will try to give you some context for each question so you can associate it with the correct answer. There are 424 questions in the Technician Class pool. Obviously we can't explain every question in depth in 7 hours so we may cover a subject that has 3 questions in the pool with variations of the same answer and assume you will be smart enough to figure it out. The study guide and question pool are both good reference tools but I will try to give you meaning to each question so you *understand why.* I hope you find the class helpful.

There are 10 elements to the test (T0 through T9). Each element concentrates on a certain subject or area in ham radio. Each element may be split into several groups for emphasis on certain areas. Every question has a question number such as (T5A11). (T) is for the pool ID (Technician), (5) is the element number, (A) is the group number in that element and (11) is the question number in that group. In our study guide, *the question will be in italics* and **the answer will be in bold** followed by the question number for reference**.** It will generally be given as a statement such as; *An electrical component used to connect or disconnect electrical circuits* is a **switch** (T6A08). Not every question number will be covered specifically but you will be given enough knowledge to figure it out. Occasionally you will see a question number in red followed by another number. These are the top ten missed questions so take a little extra time with them to make sure you understand them.

What is Amateur Radio? Also known as Ham Radio, it's a hobby enjoyed by millions of people around the world for communicating, experimenting and meeting people with the same interests. Hams can be young, old, men, women, boys and girls. Kids as young as seven years old have gotten amateur radio licenses and many are active into their eighties and more. Most of the astronauts that go to the International Space Station are licensed radio amateurs. There is several radio set ups on board that they use to communicate with schools and others as they travel in space. So let's get started on your ham radio adventure.

ELEMENT 1 GROUP A
FCC Rules
[6 Exam Questions - 6 Groups]

The FCC's Part 97 is the part of the radio regulations that govern the Amateur Radio Service. Part 97.1 lists five "purposes" for the existence of amateur radio. Recognition of its usefulness in providing emergency and public-service communications and use of amateur radio as a way to help people become better technicians and operators are a couple of the stated purposes.

One purpose of the Amateur Radio Service as stated in the FCC rules and regulations is **advancing skills in the technical and communication phases of the radio art.** (T1A01)

The agency that regulates and enforces the rules for the Amateur Radio Service in the United States **is the FCC.** (T1A02)

Because noise and interference are part of the challenges of ham radio, phonetics often make it easier to understand call signs. **N**ovember **eight B**ravo **Z**ulu **N**ovember is easier to understand in high noise situations than N8BZN.

There are no FCC rules regarding the use of the phonetic alphabet in station identification in the Amateur Radio service but **it is encouraged.** (T1A03)

The official amateur radio license authorization is the electronic record that exists in the FCC Universal Licensing System (ULS). After you pass the test your information will be sent to the FCC and posted on the ULS. Paper licenses are no longer issued, although you can log into the FCC website and print out a paper copy if you wish. Basically, when your license appears in the ULS, you are a licensed ham.

So, the proof that the FCC has issued an operator/primary license grant is **the license appears in the FCC ULS database.** (T1A05)

The number of operator/primary station license grants that may be held by any one person **is one**. (T1A04)

Many ham operators around the world have set up beacon transmitters on special frequencies that repeatedly transmit their call in Morse code 24 hours a day at low power. Other hams can tune to those frequencies to check propagation to other parts of the world.

The FCC Part 97 definition of a beacon **is an amateur station transmitting communications for the purposes of observing propagation or related experimental activities.** (T1A06)

The FCC Part 97 definition of a space station **is an amateur station located more than 50 km above the Earth's surface.** (T1A07)

In order for repeaters and auxiliary stations in an area not to interfere with one another, the FCC relies on volunteer frequency coordinators to properly space repeater frequencies from one another. The hams in a particular area or region that will be using the service select these Volunteer Frequency Coordinators.

The entity that recommends transmit/receive channels and other parameters for auxiliary and repeater stations **is a Volunteer Frequency Coordinator recognized by local amateurs.** (T1A08)

Frequency Coordinators are selected by **Amateur operators in a local or regional area whose stations are eligible to be repeater or auxiliary stations.** (T1A09)

One of the reasons amateur radio exists at all is that ham radio operators are uniquely qualified to provide emergency and public-service communications very quickly. As a result, many hams consider it an obligation to be prepared to help out when called upon. This includes having the proper equipment and knowing the proper operating procedures. One of these organizations is The Radio Amateur Civil Emergency Service (RACES)

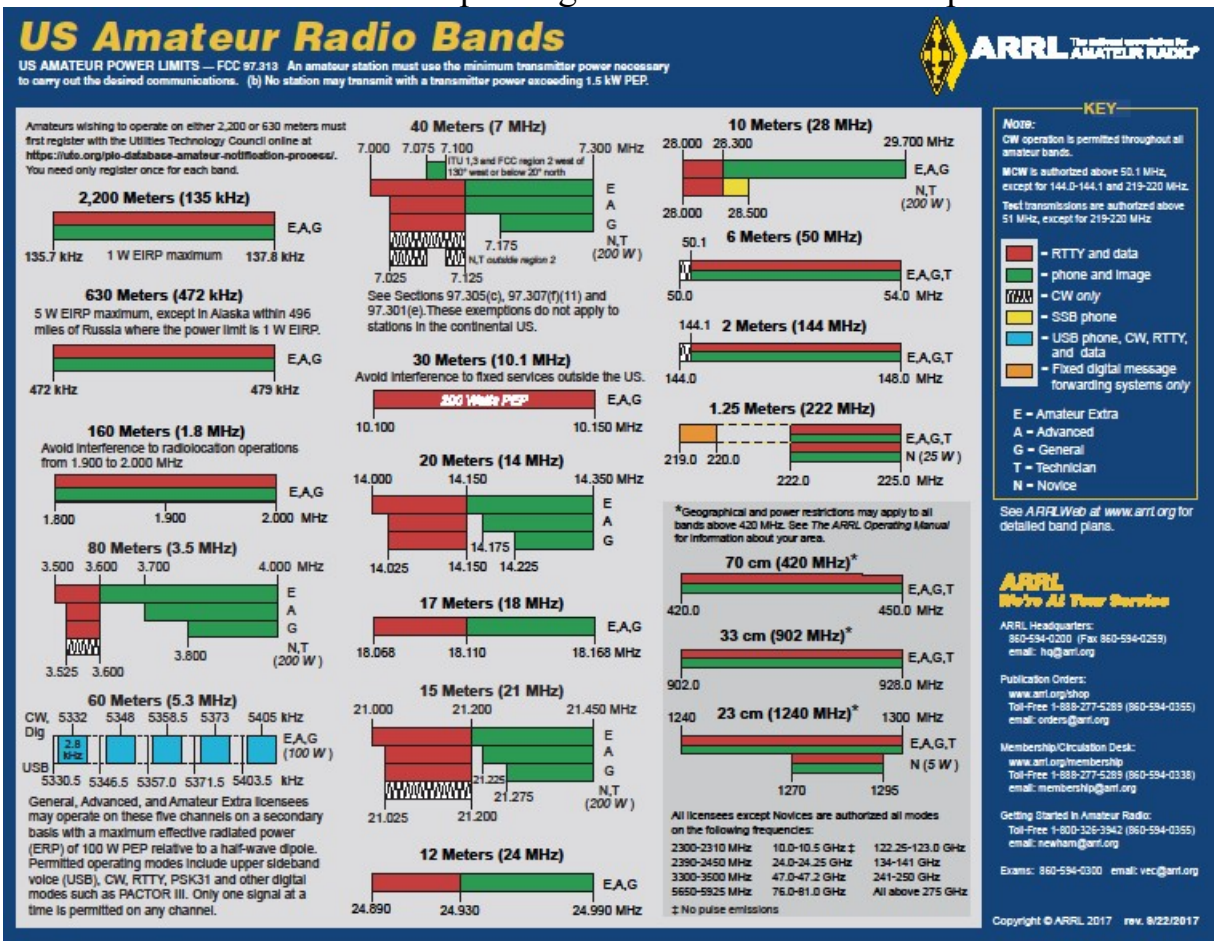
The Radio Amateur Civil Emergency Service (RACES) is **all of these things.**
A radio service using amateur frequencies for emergency management or civil defense communications;
A radio service using amateur stations for emergency management or civil defense communications;
An emergency service using amateur operators certified by a civil defense organization as being enrolled in that organization;
All of these choices are correct. (T1A10)

ELEMENT 1 GROUP B

The frequency range available for phone operation by Technician licensees is **28.300 MHz to 28.500 MHz.** (T1B01)

Contact with an amateur radio station on the International Space Station (ISS) on VHF bands may be made **by any amateur holding a Technician or higher-class license**. (T1B02)

So how do we know what our privileges are as a Ham Radio Operator?



Lets look at the band plan. First what is a band plan? Well, beyond the privileges established by the FCC it's a voluntary guideline for ham operators to use to help avoid interference and coordinate usage. The upper and lower limits of a band and certain usage limitations are part of the FCC privileges.

Many bands have split frequency ranges for different class licenses. Lets look at the 80 meter band and break it down a little bit. The lower limit on the left is 3.5 MHz and the upper limit on the right is 4.0 MHz. An Amateur Extra licensee can use the entire band with 3.5 to 3.6 MHz reserved for RTTY and data, including CW, and 3.6 to 4.0 MHz for phone and image.

An Advanced licensee can use 3.525 to 3.6 MHz for data and 3.7 to 4.0 MHz for phone. General licensees have the same data privileges as Advanced license holders but are limited to 3.8 to 4.0 MHz for phone. There are a few bands with split frequency privileges and typically the higher the license class, the more privileges the FCC allows. Next you can see that Novice and Technician class licensees have CW only privileges from 3.525 to 3.6 MHz. They cannot use RTTY, FT8 or any other data format just CW, and they are limited to 200 watts PEP in all of the HF bands. Now look at the 10 meter band in the upper right and notice that this is the only HF band that Novice and Techs have data and phone privileges. Above the HF band, except for a few limitations,

Technicians can use the full 1500 watts PEP just the same as higher license class operators.

Study the 6 meter and 2 meter bands and know what the frequency ranges are.

A couple of other FCC limitations are the frequencies 50.0 to 50.1 MHz and 144.0 to 144.1 MHz are reserved for CW for all licensees and 219.0 to 220.0 MHz is reserved for "Fixed Digital Message Forwarding Systems" only. Use the Band Plan chart for the following questions.

Which frequency is within the 6-meter amateur band? **52.525 MHz** (T1B03)

Which amateur band are you using when your station is transmitting on 146.52 MHz? **2 meter band** (T1B04)

Amateurs may use the 219 to 229 segment of the 1.25 meter band for **fixed digital message forwarding systems only.** (T1B05)

A Technician class operator has HF phone privileges **in the 10 Meter band only.** *(T1B06)*

The VHF/UHF band segments limited to CW only are **50.0 to 50.1 MHz and 144.0 to 144.1 MHz.** (T1B07)

SSB phone may be used in amateur bands above 50 MHz **in at least some segment of all these bands.** (T1B10)

In most of the Amateur Radio bands, we are the primary or exclusive user. There are some bands or areas of bands that we share with other users. In those areas we are the secondary users. If you hear data or any activity that is NOT Amateur related, as a secondary user we need to stay away.

U.S. Amateurs are restricted in segment of bands where the Amateur Radio Service is secondary so **U.S. Amateurs may find non-amateur stations in those portions, and must avoid interfering with them.** (T1B08)

When is willful interference to other amateur radio stations permitted? **At No Time!** (T1A11)

You should not set your transmit frequency to be exactly at the edge of an amateur band or sub-band:
To allow for calibration error in the transmitter frequency display:
So that modulation sidebands do not extend beyond the band edge:
To allow for transmitter frequency drift;
All of these choices are correct. (T1B09)

ELEMENT 1 GROUP C

Remember from the band plan chart, in the HF frequencies below 10 meters, Technicians can only use CW (Morse Code) and they are limited to 200 watts peak envelope power.

The maximum peak envelope power output for Technician class operators in their HF band segment is **200 watts.** (T1B11)

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

In recent years the FCC has reduced the number of license classes to 3.

New licenses currently available from the FCC are for the **Technician, General and Amateur Extra class**. (T1C01)

After you pass the test the FCC will assign you the next available license number in sequence. Once you have a license, **any licensed Amateur** *may select a desired call sign under the vanity call sign rules.* (T1C02)

The call sign you select must meet some rules. It cannot be assigned to someone else and must be in the appropriate format for your license class. For example only Amateur Extras may hold a 1X2 or 2X1 call sign. (W8PI or KA8G)

An example of a valid Technician class call sign format is **KF1XXX.** (T1C05)

The example is a 2X3 call sign.

Amateur radio is not intended for and may not be used for commercial or business use. Unless either country prohibits it, any ham can talk to any other ham anywhere as long as the communications are limited to the purpose of the amateur service or personal remarks.

The type of international communications an FCC-licensed amateur radio station is permitted to make is **communications incidental to the purposes of the Amateur Radio Service and remarks of a personal character.** (T1C03)

The FCC will almost never send you something in the mail anymore. They use email for almost everything today so make sure to keep both your physical address and your email address up to date in the ULS.

When the FCC is unable to reach you by email, the result may be **revocation of the station license or suspension of the operator license.** (T1C04)

Revocation of the station license or suspension of the operator license **may result from failure to provide and maintain a correct email address with the FCC.** (T1C07)

A location that an FCC-licensed amateur station may transmit may include **from any vessel or craft located in international waters and documented or registered in the United States.** (T1C06)

The normal term for an FCC-issued primary station/operator amateur radio license grant **is ten years.** (T1C08)

The grace period for renewal if an amateur license expires **is two years.** (T1C09)

ELEMENT 1 GROUP D

After passing the examination for your first amateur radio license you may operate a transmitter on an Amateur Radio band **as soon as your operator/station license grant appears in the FCC's license database.** (T1C10)

If your license has expired and is still within the allowable grace period, may you continue to operate a transmitter on Amateur Radio bands? **No, you must wait until the license has been renewed**. (T1C11)

Occasionally, other countries may decide they don't want certain countries talking to their Amateur radio operators. The FCC from time to time will issue public notices of current arrangements for international communications and the ARRL maintains a list on their website of certain limitations.

FCC-licensed amateur radio stations are prohibited from exchanging communications with **any country whose administration has notified the International Telecommunications Union (ITU) that it objects to such communications.** (T1D01)

One-way transmissions by an amateur station is prohibited for **broadcasting**. (T1D02)

The only time you can transmit messages encoded to obscure their meaning is **when transmitting control commands to space stations or radio control craft.** (T1D03)

An amateur station is authorized to transmit music using a phone emission **when incidental to an authorized retransmission of manned spacecraft communications.** (T1D04)

Amateur radio operators may 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.** (T1D05)

There are restrictions concerning transmission of language that may be considered indecent or obscene. Simply, **any such language is prohibited.** (T1D06)

The only amateur stations that can automatically retransmit the signals of other amateur stations are **repeater, auxiliary, or space stations.** (T1D07)

The control operator of an amateur station may receive compensation for operating that station **when the communication is incidental to classroom instruction at an educational institution.** (T1D08)

ELEMENT 1 GROUP E

The FCC rules define broadcasting for the Amateur Radio Service as **transmissions intended for reception by the general public.** (T1D10)

Amateur stations may transmit information in support of broadcasting, program production or news gathering, assuming no other means is available, **only where such communications is directly relate to the immediate safety of human life or protection of property**. (T1D09)

An amateur station may transmit without on-the-air identification **when transmitting signals to control model craft**. (T1D11)

The control operator is very important in Amateur radio. An Amateur radio station must always have a control operator and the control operator is responsible for the operation of that station. The default control operator is the station licensee.

An amateur station is **never** *permitted to transmit without a control operator.* (T1E01)

The control operator of a station communicating through an amateur satellite or space station can be **any amateur whose license privileges allow them to transmit on the satellite uplink frequency.** (T1E02)

The station control operator must be designated by **the station licensee.** (T1E03)

Transmitting privileges of an amateur station are determined by **the class of operator license held by the control operator.** (T1E04)

An amateur station control point is **the location at which the control operator function is performed.** (T1E05)

Under normal circumstances, a Technician class licensee can **at no time** *be the control operator of a station operating in an exclusive Amateur Extra class operator segment of the amateur bands.* (T1E06)

When the control operator is not the station licensee, **the control operator and the station licensee are responsible** *for proper operation of the station.* (T1E07)

An example of automatic control is **repeater operation.** (T1E08)

The following is true of remote control operation:
The control operator must be at the control point:
A control operator is required at all times:
The control operator indirectly manipulates the controls:
All of these choices are correct (T1E09)

An example of remote control as defined in Part 97 **is operating the station over the Internet. (T1E10) #1**

The FCC presumes that the control operator of an amateur station, unless documentation to the contrary is in the station records is **the station licensee.** (T1E11)

ELEMENT 1 GROUP F

The station and its records must be available for FCC inspection **at any time upon request by an FCC representative.** (T1F01)

When using tactical identifiers such as "Race Headquarters", your station must transmit the station's FCC-assigned call sign **at the end of each communication and every ten minutes during a communication.** (T1F02) (T1F03)

That's not just during an event. Your call sign must be transmitted every 10 minutes during a conversation and at the end of every conversation ALL OF THE TIME.

An acceptable language to use for station identification when operating in a phone sub-band **is English.** (T1F04)

When call sign identification is required for a station transmitting phone signals you may **send the call sign using a CW or phone emission.** (T1F05)

If you are out of your area talking on HF and want to let people know you are in, let's say Pennsylvania, I might say "N8BZN stroke W3" so they don't think you are in Michigan. W3 is the Pennsylvania call area.

A self-assigned indicator **such as KL7CC stroke W3, KL7CC slant W3 or KL7CC slash W3** *is acceptable when using a phone transmission. (T1F06)*

A third party communication is information sent from one amateur operator to another amateur operator for or to a non-amateur (a third party). The ARRL maintains a list of countries that have third party agreements with the United States online.

When a non-licensed person is allowed to speak to a foreign station using a station under the control of a Technician class control operator **the foreign station must be one with which the U.S. has a third-party agreement.** (T1F07)

The definition of Third Party Communications is **a message from a control operator to another amateur station control operator on behalf of another person.** (T1F08)

An amateur station that simultaneously retransmits the signal of another amateur station on a different channel or channels is **a Repeater station**. (T1F09)

The person held accountable should a repeater inadvertently retransmit communications that violate the FCC rules is **the control operator of the originating station.** (T1F10)

The requirement for the issuance of a club station license grant is that **the club must have at least four members.** (T1F11)

End of element 1

Technician Class Study Guide

ELEMENT 2 GROUP A

Operating Procedures

[3 Exam Questions - 3 Groups]

There are 2 basic ways to communicate in VHF bands and above. Simplex and Duplex.

The term that describes an amateur station that is transmitting and receiving on the same frequency is **Simplex**. (T2A11)

Certain simplex frequencies have been set aside in the VHF and above bands for local or national calling frequencies. If you are out of town and call on these frequencies, someone will probably answer you. They are also used for local communications, when able, to avoid tying up the repeater.

The national calling frequency for FM simplex operations in the 2 meter band is **146.520 MHz.** (T2A02)

The most common type of communications in these bands are repeaters. Repeaters are located on top of tall buildings or on tall communications towers to improve the coverage area. Communications in these bands is typically line-of-site so the higher the antenna the farther they cover.

Repeaters use full duplex communications. That means they transmit on one frequency and receive on another simultaneously. To prevent the repeater from talking to itself the frequencies are offset from one another.

The repeater offset is **the difference between the repeaters transmit frequency and its receive frequency.** (T2A07)

Ex: 2 meter repeater TX 146.720 MHz / RX 146.120 MHz /-600 kHz offset
Ex: 70 cm repeater TX 442.650 MHz / RX 447.650 MHz /+5 MHz offset

The common repeater frequency offset in the 2-meter band is **plus or minus 600 kHz. (T2A01) #9**

The common repeater frequency offset in the 70 cm band is **plus or minus 5 MHz.** (T2A03)

The meaning of the procedural signal "CQ" is **"Calling any station."** (T2A08)

The appropriate way to call another station on a repeater or to respond to a CQ call is to **say the other station's call sign followed by your call sign.** (T2A04) (T2A05)

It is required when making on-the-air test transmissions that you **identify the transmitting station.** (T2A06)

A brief statement indicating that a station is listening on a repeater and looking for a contact is **the station call sign followed by the word "monitoring".** (T2A09)

Before calling CQ you should:
Listen first to be sure that no one else is using the frequency;
Ask if the frequency is in use;
Make sure you are in your assigned band;
All of the above (T2A12)

We talked before about much of the band plan being voluntary but certain privileges are not. Band limitations, licensee class limitations and certain mode limitations are set by the FCC and must be adhered to. Other things are voluntary guidelines to help keep things orderly and reduce interference.

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

ELEMENT 2 GROUP B

What are Carrier Squelch, CTCSS, DCS and DTMF?

Carrier Squelch – Circuitry that un-mutes the audio output of a receiver with the presence of any signal or carrier.

CTCSS – **C**ontinuous **T**one **C**oded **S**quelch **S**ystem: A low frequency subaudible tone, transmitted with your voice, required to access many repeaters.

DCS – **D**igital **C**oded **S**quelch: A low frequency digital signal, transmitted with your voice, required to access some repeaters.

DTMF – **D**ual **T**one **M**ulti **F**requency: Two different tones sent simultaneously with the push of a button on a keypad.

A sub-audible tone transmitted along with normal voice audio to open the squelch of a receiver is **CTCSS.** (T2B02)

Some of the reasons you are unable to access a repeater whose output you can hear is;
Improper transceiver offset ;
The repeater may require a proper CTCSS tone from your transceiver;
The repeater may require a proper DCS tone from your transceiver ;
All of these choices are correct (T2B04)

You can use a Touch-Tone microphone to access IRLP, Echolink and other Internet linking systems to your radio.

The type of signaling that uses pairs of audio tones is **DTMF**. (T2B06)

Simplex channels are designated in the VHF/UHF bands **so stations within range of each other can communicate without tying up a repeater.** (T2B09)

You can join a digital repeater's "talk group" **if you program your radio with the group's ID or code.** (T2B07)

The Q-codes are sets of abbreviations that were in use from the beginning of the last century in order to simplify radiotelegraphy communication among the ham operators. There are hundreds of ham radio Q codes. Here are the two that you need to know about. QR**M** is **M**an-made noise, as in interference from another station.

The Q signal that indicates you are receiving interference from other stations is **QRM.** (T2B10)

The Q signal that indicates that you are changing frequency is **QSY.** (T2B11)

The purpose of the color code used on DMR repeater systems **is to match the repeater color code for access.** (T2B12)

The purpose of the squelch function **is to mute the receive audio when a signal is not present.** (T2B13)

The VHF/UHF transceiver's "reverse" function is used **to listen on a repeater's input frequency.** (T2B01)

A linked repeater network is **a network of repeaters in which signals received by one repeater are transmitted by all the repeaters in the network.** (T2B03)

If your FM transmissions audio is distorted on voice peaks, it might be that **you are talking too loudly.** (T2B05)

Accidental interference is common. Propagation may change and suddenly a station that wasn't audible a few minutes ago becomes strong enough to disrupt your contact. These things happen. Everyone should make sure to operate in a way that minimizes the possibility of causing interference. And if it does happen, be courteous.

When two stations transmitting on the same frequency interfere with each other, **the stations should negotiate continued use of the frequency.** (T2B08)

ELEMENT 2 GROUP C

FCC rules are not a suggestion. They are rules and must be obeyed at all times. That being said, the FCC will make exceptions in certain emergency situations. If ham radio is the ONLY way to communicate in an emergency, and you have to break the rules, do what you have to do. But it better be the last resort!

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

Amateur station control operators are permitted to operate outside the frequency privileges of their license class **only if necessary in situations involving the immediate safety of human life or protection of property.** (T2C09)

The Amateur Radio Emergency Service (AR7ES) is a group of **licensed amateurs who have voluntarily registered their qualifications and equipment for communications duty in the public service.** (T2C06)

RACES is **an FCC part 97 amateur radio service for civil defense communications during national emergencies.** (T2C04)

Hams help coordinate emergency response communications through something called a NET whenever they're needed. During emergencies they may pass messages to hams in other areas and help coordinate response activities. These messages (called traffic) follow a set formal structure to insure the information is transferred correctly and routed properly. They practice these activities with informal or social nets on a regular basis to stay current and comfortable with net operations. There are many nets available to the Technician licensee to practice these skills, learn the procedures and volunteer in your community.

One typical duty of a net control station is to **call the net to order and direct communications between stations checking in.** (T2C02)

A standard practice when you participate in a net is **unless you are reporting an emergency, transmit only when directed by the net control station.** (T2C07)

A technique to ensure that voice messages containing unusual words are received correctly is to **spell the words using a standard phonetic alphabet.** (T2C03)

The term "traffic" in net operation refers to **messages exchanged by net stations.** (T2C05)

The preamble of a formal traffic message contains **the information needed to track the message.** (T2C10)

The term "check," in a Radiogram header is **the number of words or word equivalents in the text portion of the message.** (T2C11)

One characteristic of good traffic handling is **passing messages exactly as received.** (T2C08)

End Of Element 2

Technician Class Study Guide

ELEMENT 3 GROUP A

Radio Waves

[3 Exam Questions - 3 Groups]

There are dozens of different antenna styles. The yagi and vertical are the two we use the most. The horizontal yagi is mostly for longer distances and verticals are used mostly for local.

Verticals or dipoles can be used for either. Most local repeater contacts are made on verticals.

The antenna polarization normally used for long-distance CW and SSB contacts on the VHF and UHF bands is **Horizontal.** (T3A03)

If the antennas at opposite ends of a VHF or UHF line of sight radio link are not using the same polarization **the received signal strength is reduced.** (T3A04)

When using a directional antenna, your station might be able to access a distant repeater if buildings or obstructions are blocking the direct line of sight path if you **try to find a path that reflects signals to the repeater.** (T3A05)

Resulting 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.** (T3A09)

The term picket fencing is a **rapid flutter on mobile signals due to multipath propagation.** (T3A06)

VHF signal strengths sometimes vary greatly when the antenna is moved only a few feet because **multipath propagation cancels or reinforces signals.** (T3A01)

The effect of vegetation on UHF and microwave signals **is absorption.** (T3A02)

The effect that multipath propagation has on data transmissions is that **error rates are likely to increase.** (T3A10)

The region of the atmosphere that can refract or bend HF and VHF radio waves is **the ionosphere.** (T3A11)

The weather condition that might decrease range at microwave frequencies is **precipitation**. (T3A07)

A likely cause of irregular fading of signals propagated by the ionosphere is **random combining of signals arriving via different paths**. (T3A08)

Moisture and light rain have less effect on lower frequencies than they do on higher frequencies. Once you get above about 900 MHz rain will have more and more effect and start decreasing the range. The wavelength gets shorter as the frequency gets higher and is more easily blocked by raindrops.

Fog and rain will **have little effect** *on signals in the 10 meter and 6 meter bands.* (T3A12)

ELEMENT 3 GROUP B

The formula for converting wavelength to frequency or frequency to wavelength is 300=FxW. So, 300 divided by either one will give you the other.

300/146 MHz = 2.05 or approximately 2 meters
300/7.3 MHz = 41.0 or approximately 40 meters

300/20 Mtr = 15 MHz
300/160 Mtr = 1.875 MHz

The formula for converting frequency to approximate wavelength in meters is **wavelength in meters equals 300 divided by frequency in megahertz.** (T3B06)

The relationship between the electric and magnetic fields of an electromagnetic wave is **they are at right angles**. (T3B01)

The relationship between wavelength and frequency is **the wavelength gets shorter as frequency increases.** (T3B05)

In addition to frequency to identify the different amateur radio bands we also use **the approximate wavelength in meters.** (T3B07)

The two components of a radio wave are the **electric and magnetic fields.** (T3B03)

The property of a radio wave that defines its polarization is **the orientation of the electric field. (T3B02) #8**

The velocity of a radio wave traveling through free space **is the speed of light.** (T3B04)

The approximate velocity of a radio wave in free space is **300,000,000 meters per second.** (T3B11)

High Frequency (HF) is the frequency range used for long distance communications. The ionosphere reflects the long wavelengths from 3 to 30 MHz more easily than higher frequencies.

Very High Frequency (VHF) is the frequency range used mostly for local or short-range communications. The shorter wavelengths from 30 to 300 MHZ are rarely reflected by the ionosphere but can bounce in temperature inversions near the ground called tropospheric ducting for about 300 miles.

Ultra High Frequency (UHF) is the frequency range from 300 to 3000 MHz and is usually not reflected by the ionosphere. It is used mostly for local short-range communications and experimenting.

The frequency range referred to as HF is **3 to 30 MHz.** (T3B10)

The frequency range referred to as VHF is **30 to 300 MHz.** (T3B08)

The frequency range referred to as UHF is **300 to 3000 MHz.** (T3B09)

ELEMENT 3 GROUP C

VHF frequencies and above are rarely heard outside your local area because they are not usually reflected by the ionosphere. There is a form of propagation caused by temperature inversions usually associated with weather fronts called Tropospheric Ducting. The signal can bounce around in a warm moist layer of air for more than 300 miles.

Simplex UHF signals are rarely heard beyond their radio horizon because **UHF signals are usually not propagated by the ionosphere.** (T3C01)

The mode responsible for allowing over-the-horizon VHF and UHF communications to ranges of approximately 300 miles on a regular basis is **tropospheric ducting .** (T3C06)

Tropospheric ducting is caused by **temperature inversions in the atmosphere**. (T3C08)

The Radio Horizon for VHF and UHF radio signals is more distant than the visual horizon because **the atmosphere refracts radio waves slightly.** (T3C11)

The effect that may allow radio signals to travel beyond obstructions between the transmitting and receiving stations is **Knife-edge diffraction.** (T3C05)

The Aurora (northern lights) is made up of charged particles in the lower layers of the ionosphere. Because the waves of the aurora are constantly changing, the signals may fluctuate rapidly and sound distorted.

A characteristic of VHF signals received via auroral reflection is **that they are distorted and signal strength varies considerably.** (T3C03)

Bands that may provide long distance communications via the ionosphere's F region during the peak of the sunspot cycle are the **6 or 10 meter bands.** (T3C10)

Generally, the best time for long-distance 10 meter band propagation via the F layer is **from dawn to shortly after sunset during periods of high sunspot activity.** (T3C09)

A meteor burning up in the atmosphere leaves a trail of ionized gas for several seconds. Meteor scatter propagation bounces signals off of these ionized gas trails for up to 1500 miles.

The band best suited for communicating via meteor scatter is the **6 meter band**. (T3C07)

The propagation type most commonly associated with occasional strong over-the-horizon signals on the 10, 6, and 2 meter bands is **Backscatter**. (T3C04)

A characteristic of HF communications compared with communications on VHF and higher frequencies is that **long distance ionospheric propagation is far more common on HF**. (T3C02)

End Of Element 3

Technician Class Study Guide

ELEMENT 4 GROUP A

Radio Waves

[2 Exam Questions - 2 Groups]

Computers can be used for a variety of things in ham radio today. There are several programs to log your contacts that are especially useful for contesting. They automatically check for duplicate contacts and make sure you have all of the proper exchange information. They can also be interfaced directly to the radio to send and receive CW or digital modes. Many radios today have built in USB interfaces and most others can be interfaced through the computers sound card. It is usually very simple to connect the computers speaker output to the microphone input on the radio and receive audio from the radio to the microphone input on the computer.

The transceiver audio input and output in a station configured to operate using FT8 are connected **to the audio input and output of a computer running WSJT-X software.** (T4A04)

Signals used in a computer-radio interface for digital mode operation are **receive audio, transmit audio, and transmitter keying.** (T4A06)

Connections made between a computer and a transceiver to use computer software when operating digital modes **are the computer "line in" to transceiver speaker connector.** (T4A07)

The function performed with a transceiver and a digital mode hot spot, **is communication using digital voice or data systems via the Internet**. (T4A10)

An electronic keyer **is a device that assists in manual sending of Morse code.** (T4A12)

The negative power return of a mobile transceiver in a vehicle should be connected **at the 12 volt battery chassis ground.** (T4A11)

The conductor preferred for bonding at RF is a **flat copper strap.** (T4A08)

An appropriate power supply rating for a typical 50 watt output mobile FM transceiver is **13.8 volts at 12 amperes.** (T4A01)

Short, heavy-gauge wires are used for a transceiver's DC power connection **to minimize voltage drop when transmitting.** (T4A03)

You can determine the length of time that equipment can be powered from a battery if you **divide the battery ampere-hour rating by the average current draw of the equipment.** (T4A09)

An RF power meter should be installed **in the feed line, between the transmitter and antenna.** (T4A05)

When selecting an accessory SWR meter you should consider **the frequency and power level at which the measurements will be made.** (T4A02)

ELEMENT 4 GROUP B

The effect of excessive microphone gain on SSB transmissions is **distorted transmitted audio.** (T4B01)

To adjust the squelch so that a weak FM signal can be heard, **you should set the squelch threshold so that receiver output audio is on all the time.** (T4B03)

The result of tuning an FM receiver above or below a signal's frequency is **distortion of the signal's audio.** (T4B12)

An appropriate receive filter bandwidth for minimizing noise and interference for SSB reception is **2400 Hz. (T4B10) #10**

A specific group of stations can be selected on a digital voice transceiver **by entering the group's identification code.** (T4B09)

A DMR "code plug" contains **access information for repeaters and talkgroups.** (T4B07)

Something you must be program into a D-STAR digital transceiver before transmitting is **your call sign.** (T4B11)

Having multiple receive bandwidth choices on a multimode transceiver **permits noise or interference reduction by selecting a bandwidth matching the mode. (T4B08) #7**

The control used if the voice pitch of a single-sideband signal returning to your CQ call seems too high or low is **the RIT or clarifier.** (T4B06)

To enter the operating frequency on a modern transceiver use **the keypad or VFO knob.** (T4B02)

To enable quick access to a favorite frequency on your transceiver **store it in a memory channel.** (T4B04)

The scanning function of an FM transceiver **tunes through a range of frequencies to check for activity.** (T4B05)

End Of Element 4

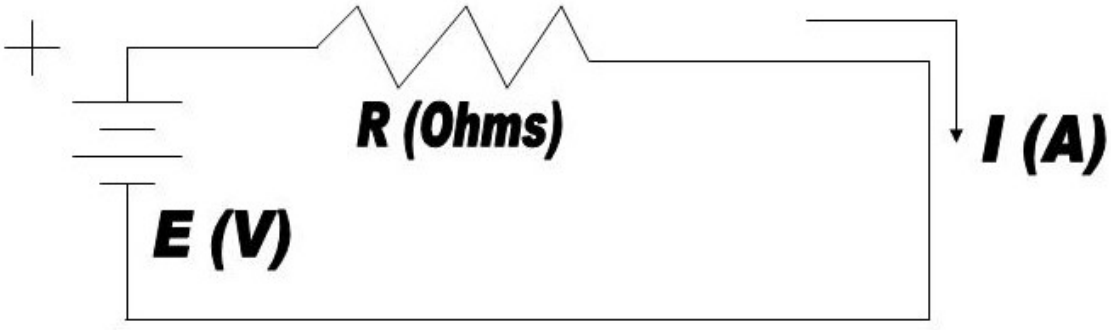
Technician Class Study Guide

ELEMENT 5 GROUP A

Electrical Principals

[4 Exam Questions - 4 Groups]

This figure shows a simple electric circuit consisting of a voltage source or battery (E), a resistor (R), and some wires to connect the battery to the resistor. When connected, the battery will cause current (I) to flow through the circuit.



The three basic parameters of this circuit are electromotive force (E), current (I) and resistance (R). Electromotive force (EMF) is measured in volts (V).

The electrical term for the force that causes electron flow is **voltage.** (T5A05)

Current is the flow of electrons in a circuit. In this figure the (I) stands for current. Current flows from the positive (+) terminal of the voltage source through the circuit to the negative terminal of the voltage source. Current is measured in amperes, and we use the letter (A) to stand for amperes.

The name for the flow of electrons in an electric circuit is **current.** (T5A03)

Electrical current is measured in **amperes.** (T5A01)

Resistance is the third parameter. As the name implies, resistance opposes the flow of electrons in a circuit. The higher the resistance, the smaller the current. We use the letter R to stand for resistance. Resistance is measured in ohms, and we use the Greek letter Ω (omega) to stand for ohms. Something that conducts electricity well is said to have very little resistance to allow current to flow. An insulator has very high resistance and does not allow current to flow.

The unit of electrical resistance is **Ohms**. (T5A04)

Metals are generally good conductors of electricity because **they have many free electrons.** (T5A07)

A good electrical insulator is **glass**. (T5A08)

The type of current you get out of a wall socket is different from the current you get from a battery. Unlike the battery, the polarity of this voltage changes from positive to negative and back to positive on a regular basis. In fact, the frequency at which it makes a complete cycle is 60 times per second or 60 hz. Because of this we call it **A**lternating **C**urrent or AC.

The type of current flow opposed by resistance is;
Direct Current;
Alternating Current;
RF Current;
All of these choices are correct. (T5A11)

The rate at which electrical energy is used is power (P). Power is measured in watts (W). Something that consumes power is called a load. If you know the current and the voltage you can calculate the power being consumed. We will go into that a little later.

The rate at which electrical energy is used is **power**. (T5A10)

Power is measured in **watts**. (T5A02)

The number of times per second that an alternating current makes a complete cycle is the **frequency.** (T5A12)

The unit of frequency is **Hertz**. (T5A06)

Alternating current is **current that alternates between positive and negative directions.** (T5A09)

ELEMENT 5 GROUP B

In radio we use the metric system for units of measurement because the numbers cover a wide range of values. Kilo is one thousand and milli is one thousandth. Case is important. Remember that M means one million and m means one thousandth.

Prefix	Abbreviation	Numerical	Exponential
Giga	G	1,000,000,000	10-9
Mega-	M	1,000,000	10-6
Kilo-	k	1,000	10-3
----	----	1	10-0
Milli-	m	0.001	10-3
Micro-	u	0.000001	10-6
Nano-	n	0.000000001	10-9
Pico-	p	0.000000000001	10-12

1,500,000 Hz = 1,500 kHz = 1.5 MHz

2.425 GHz = 2,425 MHz = 2,425,000 kHz = 2,425,000,000 Hz

1,000,000 picofarads = 1 microfarad = 0.000001 farad

When doing conversions on the test, make sure you use the correct suffix. Don't confuse 3.525 MHz with 3.525 kHz. 3.525 might be the right answer but you need to DOUBLE CHECK THE SUFFIX.

1 milliamperes = .001 amperes so 1000 milliamperes = 1 ampere

500 milliamperes = ½ ampere = .500 amperes = .5 amperes

1.5 amperes is the same as **1500 milliamperes.** (T5B01)

3000 milliampere, is equal to **3 amperes**. (T5B06)

1,500,000 hertz is equal to **1500 kHz**. **(T5B02) #4**

3.525 MHz is equal to **3525 kHz**. (T5B07)

The frequency that is equal to 28,400 kHz is **28.400 MHz.** (T5B12)

2425 MHz is equal to **2.425 GHz**. (T5B13)

One kilovolt is equal to **one thousand volts**. (T5B03)

One microvolt is equal to **one one-millionth of a volt.** (T5B04)

500 milliwatts is equal to **0.5 watts.** (T5B05)

1,000,000 picofarads are equal to **1 microfarad.** (T5B08)

Radio signals can vary greatly either in gain or loss. This change (plus or minus) is measured in Decibels or dB. Every change of 3dB is a change of X2 so 6dB is X4 and 9dB is X8 and so on.

Radio signals can vary greatly either in gain or loss. This change (plus or minus) is measured in Decibels or dB. Every change of 3dB is a change of X2 so 6dB is X4 and 9dB is X8 and so on.

A .07 watt transmitter with 3dB cable loss and 24 dB antenna gain would have an output power of X126 or 8.82 watts ERP.

I use a .07 watt transmitter example because that's the output power of a wi-fi router. It is very low power and will typically only work in your house. Ham operators can reprogram a wi-fi hub to work on amateur radio frequencies and with the proper coax and antenna can be used to transmit 8 or 10 miles.

First calculate the system gain. 24db – 3db = 21 dB
Take the db gain to figure the power factor. 21 dB = 126 PF
Multiply the output power by the power factor to get ERP. .07 x 126 = 8.82

dB Gain			Power Factor	dB Gain			Power Factor
1	=	X	1.26	9	=	X	8.00
2	=	X	1.60	12	=	X	15.80
3	=	X	2.00	15	=	X	31.60
4	=	X	2.50	18	=	X	63.10
5	=	X	3.00	21	=	X	126.00
6	=	X	4.00	24	=	X	252.00

The decibel value most closely represented by a power increase from 5 watts to 10 watts is **3 dB.** (T5B09)

The decibel value most closely represented by a power decrease from 12 watts to 3 watts **-6 dB**. (T5B10)

The decibel value representing a power increase from 20 watts to 200 watts is **10 dB.** (T5B11)

ELEMENT 5 GROUP C

The ability to store energy in an electric field is called **capacitance**. (T5C01)

The basic unit of capacitance the **farad**. (T5C02)

The ability to store energy in a magnetic field is called **inductance**. (T5C03)

The basic unit of inductance is the **henry**. (T5C04)

Impedance is **the opposition to AC current flow.** (T5C12)

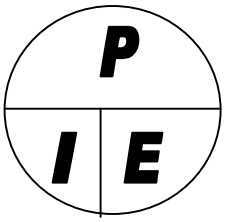
The unit of impedance is **the Ohm**. (T5C05)

The unit of frequency is **hertz**. (T5C05)

The abbreviation for megahertz is **MHz**. (T5C07)

The abbreviation for kilohertz is **kHz.** (T5C13)

The abbreviation "RF" refers to **radio frequency signals of all types.** (T5C06)



The formula to calculate electrical power in a DC circuit is
P=IxE. Usually simply referred to PIE or Power (P) equals Current (I) times Volts (E). If you know any two items you can figure the third.

120 watts divided by 12 volts equals 10 amps.

12 volts times 10 amps equals 120 watts

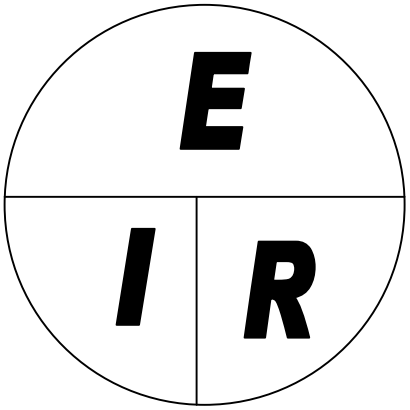
120 watts divided by 10 amps equals 12 volts

The formula used to calculate electrical power in a DC circuit is **P=IxE** (T5C08)

The power being delivered by a voltage of 13.8 volts DC and a current of 10 amperes is **138 watts.** (T5C09)

The power being delivered by a voltage of 12 volts DC and a current of 2.5 amperes is **30 watts.** (T5C10)

The current required to deliver 120 watts at a voltage of 12 volts DC is **10 amperes**. (T5C11)



So here voltage (E) equals current (I) times resistance (R). Again, any two will get you the third.

10 ohms (R) times 1 amp (I) equals 10 volts (E)

The formula used to calculate current in a circuit is, **I = E / R** (T5D01)

The formula used to calculate voltage in a circuit is, **E = I x R** (T5D02)

The formula used to calculate resistance in a circuit is, **R = E / I** (T5D03)

So that's Ohms law in a nutshell. If you can remember E=IR you will be fine. Let's do a few to make sure you understand.

What is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts? (T5D04) 90 / 3 = **30 Ohms**

What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes? (T5D05) 12 / 1.5 = **8 Ohms**

What is the resistance of a circuit that draws 4 amperes from a 12-volt source? (T5D06) 12 / 4 = **3 Ohms**

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

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

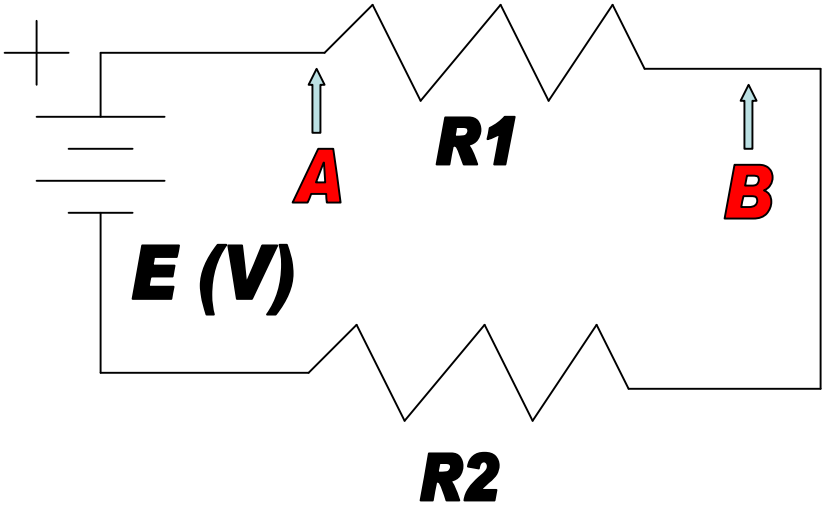
What is the current through a 24-ohm resistor connected across 240 volts? (T5D09) 120 / 24 = **10 Amperes**

What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it? (T5D10) 2 X .5 = **1 Volt**

What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it? (T5D11) 10 X 1 = **10 Volts**

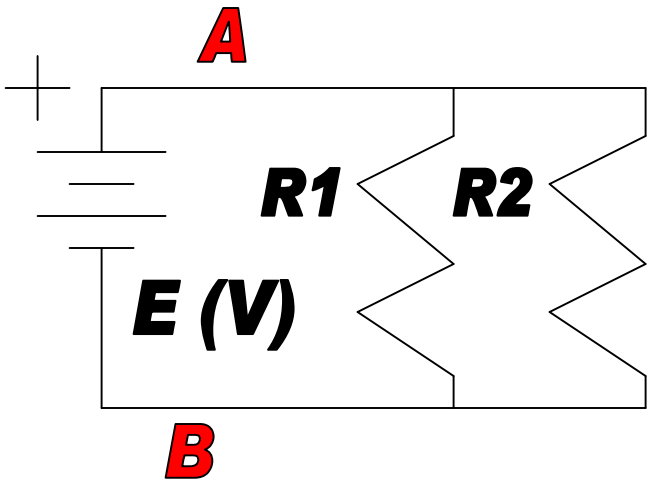
What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it? (T5D12) 2 X 10 = **20 Volt**

Remember that in a series circuit the current remains the same at all points.



The type of circuit in which DC current is the same through all components is a **series** circuit. **(T5D13) #2**

In a parallel circuit, current is divided by the components depending on value.



The type of circuit in which the voltage is the same across all components is a **parallel** *circuit***.** (T5D14)

End Of Element 5

Technician Class Study Guide

ELEMENT 6 GROUP A, B, C and D

Electrical Principals

[4 Exam Questions - 4 Groups]

T6A - Electrical components: fixed and variable resistors; capacitors and inductors; fuses; switches; batteries.

T6B - Semiconductors: basic principles and applications of solid-state devices; diodes and transistors.

T6C - Circuit diagrams; schematic symbols.

T6D - Component functions: rectification; switches; indicators; power supply components; resonant circuit; shielding; power transformers; integrated circuits.

This section will explain electronic components, what they are and what they do. We will talk about construction, symbols, schematics and diagrams. Pay particular attention to the symbols and function. You will need to be able to identify components on a schematic and understand their basic function and how they interact with one another. There is a lot to see here but don't let it scare you. Once you can recognize the few components and understand the basics of what they do, it will all fall into place.

Transistor – A transistor is a semiconductor device used to amplify or switch electrical signals and power. Some transistors are packaged individually, but many more are found embedded in integrated circuits. It is composed of semi- conductor material, usually with at least three terminals for connection to an electronic circuit. The two types of transistors you need to know about now are a Bipolar Junction transistor that has an emitter, base and collector, and a Field Effect transistor (FET) that has a gate, drain and source.

A **transistor** *can be used as an electronic switch.* (T6B03)

A **transistor** *can consist of three regions of semiconductor material.* (T6B04)

A **transistor** *can provide power gain*. (T6B10)

The term that describes a device's ability to amplify a signal is **gain**. (T6B11)

The abbreviation FET stand for **Field Effect Transistor.** (T6B08)

The type of transistor that has a gate, drain and source is a **field effect transistor.** (T6B05)

The names of the electrodes for a bipolar junction transistor is **emitter, base and collector.** (T6B12)

A device that combines several semiconductors and other components into one package is an **Integrated circuit.** (T6D09)

Resistor - The main purpose of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit. It is made of copper wires, which are coiled around a ceramic rod, and the outer part of the resistor is coated with an insulating paint. A potentiometer (*pot*) is a three-terminal resistor with a continuously adjustable tapping point controlled by rotation of a shaft or knob or by a linear slider.

The electrical component that opposes the flow of current in a DC circuit is a **resistor** . (T6A01)

The electrical parameter controlled by a potentiometer is **resistance**. (T6A03)

The component often used as an adjustable volume control is a **potentiometer** (T6A02)

Capacitor - A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals of conductive surface separated by an insulator. Measured in farads.

An electrical component that stores energy in an electric field is **a capacitor**. (T6A04)

An electrical component that consists of conductive surfaces separated by an insulator is **a capacitor**. (T6A05)

A **capacitor** *is combined with an inductor to make a resonant circuit.* (T6D08)

Inductor – An inductor, also called a coil, choke, or reactor, is a passive two-terminal electrical component that stores energy in a magnetic field when electric current flows through it. An inductor typically consists of an insulated wire wound into a coil. Measured in henrys.

An electrical component that stores energy in a magnetic field is an **inductor**. (T6A06)

An electrical component usually constructed as a coil of wire is an **inductor.** (T6A07)

A resonant or tuned circuit includes **an inductor and a capacitor connected in series or parallel.** (T6D11)

Diode - A diode is a two-terminal electronic component that conducts current primarily in one direction. It has low (ideally zero) resistance in one direction, and high (ideally infinite) resistance in the other. They can also be used to rectify AC voltage and produce light as a light emitting diode or LED. The two leads are cathode, marked with a strip, and anode.

An electronic component that allows current to flow in only one direction is a **diode**. (T6B02)

The cathode lead of a semiconductor diode is often marked on the package **with a stripe**. (T6B06)

A light emitting diode (LED) emits light due to ***Forward current***. (T6B07)

The component commonly used as a visual indicator is an **LED**. (T6D07)

The names of the two electrodes of a diode are **anode and cathode**. (T6B09)

The device or circuit that changes an alternating current into a varying direct current signal is a **rectifier**. (T6D01)

The function of an SPDT switch is **a single circuit is switched between one of two other circuits.** (T6A08)

A relay is an **electrically-controlled switch.** (T6D02)

The electrical component used to protect other circuit components from current overloads is a **fuse**. (T6A09)

The *following battery types are all rechargeable*: Nickel-metal hydride, lithium-ion and lead-acid**. All of these choices are correct.** (T6A10)

A **carbon-zinc** *battery is not rechargeable*. (T6A11)

The component that changes 120V AC house current to a lower AC voltage for other uses is a **transformer**. (T6D06)

The circuit that controls the amount of voltage from a power supply is a **regulator**. (T6D05)

A **meter** *displays an electrical quantity as a numeric value.* (T6D04)

The name of an electrical wiring diagram that uses standard component symbols is a **schematic**. (T6C01)

The way components are interconnected *is accurately represented in electrical schematics.* (T6C12)

One reason to use shielded wire is **to prevent coupling of unwanted signals to or from the wire.** (T6D03)

Use the Element 2 Exam Diagrams sheet and the Schematic Symbols sheet in the back of this guide for the following:

Component 1 in figure T1 is a **resistor**. (T6C02)

Component 2 in figure T1 is a **transistor**. (T6C03)

Component 3 in figure T1 is a **lamp**. (T6C04)

Component 4 in figure T1 is a **battery**. (T6C05)

The function of component 2 in figure T1 is to **control the flow of current**. (T6D10)

Component 6 in figure T2 is a **capacitor**. (T6C06)

Component 8 in figure T2 is a **light emitting diode.** (T6C07)

Component 9 in figure T2 is a **variable resistor**. (T6C08)

Component 4 in figure T2 is a **transformer**. (T6C09)

The switch represented by component 3 in figure T2 is a **single-pole single-throw.** (T6C07)

Component 3 in figure T3 is a **variable inductor**. (T6C10)

Component 4 in figure T3 is an **antenna**. (T6C11)

End of Element 6

Technician Class Study Guide

ELEMENT 7 GROUP A

Station Equipment

[4 Exam Questions - 4 Groups]

This element is about your radio station, common problems, troubleshooting, and basic repair. The basic radio station consists of a transmitter, a receiver, feed line and an antenna. Most radios today combine the transmitter and receiver into a single unit or transceiver. Some circuits in a transceiver include an oscillator, which generates a signal at a specific frequency that your radio uses to do a wide range of functions in the transmitter and receiver. A mixer may take that frequency added to another frequency to produce another frequency to do different things. Some stations may have a transverter that converts transceiver signals to another band.

A transceiver is **a device that combines a receiver and a transmitter.** (T7A02)

A circuit that generates a signal at a specific frequency is an **oscillator**. (T7A05)

A **Mixer** *is used to convert a radio signal from one frequency to another*. (T7A03)

A **Transverter** *is a device that converts the RF input and output of a transceiver to another band.* (T7A06)

A radios performance is determined by several things. It needs to be sensitive enough to be able to detect weak signals. It needs to be selective to only hear the signals you want and must be able to reject signals you don't want.

The term that describes the ability of a receiver to detect the presence of a signal is **sensitivity**. (T7A01)

The term that describes the ability of a receiver to discriminate between multiple signals is **selectivity**. (T7A04)

The cause of a broadcast AM or FM radio receiving an amateur radio transmission unintentionally could be that **the receiver is unable to reject strong signals outside the AM or FM band**. (T7B02)

An RF preamplifier increases the input signal level to a receiver. An RF power amplifier increases the transmitted output power from a transmitter.

An RF preamplifier is installed **between the antenna and receiver**. (T7A11)

A device that increases the transmitted output power from a transceiver is an **RF power amplifier.** (T7A10)

The function of the SSB/CW-FM switch on a VHF power amplifier is to **set the amplifier for proper operation in the selected mode. (T7A09) #4**

The function of the transceiver's PTT input is to **switch the transceiver from receive to transmit when grounded.** (T7A07)

Combining speech with an RF carrier signal is called **modulation**. (T7A08)

I*f you receive a report that your audio signal through the repeater is distorted or unintelligible the problem might be;*
Your transmitter is slightly off frequency ;
Your batteries are running low ;
You are in a bad location **;**
All of these choices are correct (T7B10)

A symptom of RF feedback in a transmitter or transceiver is **reports of garbled, distorted, or unintelligible voice transmissions.** (T7B11)

If you are told your FM handheld or mobile transceiver is over-deviating **talk farther away from the microphone**. (T7B01)

Radio Frequency Interference (RFI) can be caused by many things. Figuring out what is causing the interference and what to do about it are very important. A harmonic is a multiple of a fundamental frequency (X2, X3). Spurious emissions are kind of the same thing. They are small signals that are mixed in the radio and end up on frequencies other than the operating frequency. Overload can be caused by several things both from your radio and into your radio. Bad connections, poor wiring technique, poor grounding and Part 15 appliances are some of the reasons.

ELEMENT 7 GROUP B

R*adio frequency interference could be caused by;*
Fundamental overload;
Harmonics;
Spurious emissions;
All of these choices are correct (T7B03)

One way you could use to cure distorted audio caused by RF current on the shield of a microphone cable is install a **Ferrite choke.** (T7B04)

Fundamental overload of a non-amateur radio or TV receiver by an amateur signal can be reduced or eliminated by **blocking the amateur signal with a filter at the antenna input of the affected receiver.** (T7B05)

You can reduce overload to a VHF transceiver from a nearby FM broadcast station by adding a **Band-reject filter.** (T7B07)

If something in a neighbor's home is causing harmful interference to your amateur station you should;
Work with your neighbor to identify the offending device;
Politely inform your neighbor that FCC rules prohibit the use of devices that cause interference;
Make sure your station meets the standards of good amateur practice**;**
All of these choices are correct. (T7B08)

The first step to resolve non-fiber optic cable TV interference caused by your amateur radio transmission is to **be sure all TV feed line coaxial connectors are installed properly.** (T7B09)

If a neighbor tells you that your station's transmissions are interfering with their radio or TV reception you should **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.** (T7B06)

ELEMENT 7 GROUP C

The antenna and transmission line are the most important parts of any radio system. The best radio system in the world won't work well without a good antenna system. Proper feed line type and assembly are important. An SWR (Standing Wave Ratio) of 1 to 1 is ideal but should be below 1.5 to 1. An impedance mismatch causes a high SWR and power is lost to heat either in the feed line or the radio causing radio failure. Most radios today can sense a high SWR and reduce power to prevent radio damage. An antenna analyzer can check resonance of an antenna system to check for impedance mismatch without a radio. A dummy load is used to test a transmitter off air. It has a 50 ohm reactance so you can transmit into it safely and without interfering with other operators.

A Dummy Load consists of **a non-inductive resistor mounted on a heat sink.** (T7C03)

A reading on an SWR meter indicating a perfect impedance match between the antenna and the feed line is **1 to 1**. (T7C04)

An SWR reading of 4:1 indicates an **impedance mismatch.** (T7C06)

Power lost in a feed line is **converted into heat**. (T7C07)

An instrument that can be used to determine SWR is a **directional wattmeter.** (T7C08)

One instrument that can be used to determine if an antenna is resonant at the desired operating frequency is **an antenna analyzer.** (T7C02)

Most solid-state amateur radio transmitters reduce output power as SWR increases **to protect the output amplifier transistors.** (T7C05)

The most common cause for coaxial cable failure is moisture contamination. Ultraviolet light can break down the outer jacket and allow water to enter the cable and increase transmission line loss. The most common type of coax is foam dielectric. It has good loss characteristics up to high VHF frequencies and does not require any special tools to install or special techniques to prevent water absorption.

The most common cause for failure of coaxial cables is **moisture contamination.** (T7C09)

The outer jacket of coaxial cable should be resistant to ultraviolet light because **ultraviolet light can damage the jacket and allow water to enter the cable.** (T7C10)

A disadvantage of air core coaxial cable when compared to foam or solid dielectric types is **it requires special techniques to prevent moisture in the cable.** (T7C11)

The primary purpose of a dummy load is **to prevent transmitting signals over the air when making tests.** (T7C01)

ELEMENT 7 GROUP D

This section covers basic repair and testing, how to use various meters and basic test instruments and repair techniques.

The instrument you would use to measure electric potential or electromotive force is **a voltmeter**. (T7D01)

The correct way to connect a voltmeter to a circuit is **in parallel with the circuit.** (T7D02)

Some precautions should be taken when measuring high voltages with a voltmeter such as **ensure that the voltmeter and leads are rated for use at the voltages to be measured**. (T7D12)

An instrument is used to measure electric current is **an ammeter**. (T7D04)

When configured to measure current, a multimeter is connected to a component **in series.** (T7D03)

Measurements commonly made using a multimeter are **voltage and resistance.** (T7D07)

You might damage a multimeter if you are **attempting to measure voltage when using the resistance setting**. (T7D06)

When measuring circuit resistance with an ohmmeter you should **ensure that the circuit is not powered.** (T7D11)

The reading that indicates an ohmmeter is connected across a large discharged capacitor is **increasing resistance with time.** (T7D10)

The type of solder that should <u>not</u> be used for radio and electronic applications is **acid-core solder**. (T7D08)

The characteristic appearance of a cold solder joint is a **rough or lumpy surface.** (T7D09)

End of Element 7

Technician Class Study Guide

ELEMENT 8 GROUP A

Satellite and Digital

[4 Exam Questions - 4 Groups]

Modulation – There are only a few types of modulation you need to be concerned with now. AM or amplitude modulation is mostly used on HF frequencies and changes the amplitude of the frequency with the audio. AM has a main carrier and an upper sideband and lower sideband that carry the audio and is about 6 kHz wide. If you remove the carrier and one of the sidebands, it only occupies about 3 kHz and is called SSB or Single Sideband. Typically, lower sideband is used below 10 MHz and upper sideband above 10 MHz. Because it is concentrated into a narrow bandwidth, it is possible to use SSB over much longer ranges and in poorer conditions than other modes. For that reason VHF and UHF contesters use SSB over FM for better range.

CW or continuous wave is like sideband in that it only uses a portion of the carrier width for RF signal. It is turned on and off by a key used for sending international Morse code and occupies about 150 Hz of bandwidth. FM varies the frequency of the signal to add speech or data and is called Frequency Modulation. FM is normally used locally in the VHF and above bands because it uses a much wider bandwidth, about 15 kHz. Digital or data mode is a computer to computer communications such as packet or RTTY in which information is sent as data characters or digital information. There are ways to use digital signals in almost every mode in almost every band. We can also use Slow Scan TV and Fast Scan TV. Fast scan in NTSC format uses about 6 MHz bandwidth at 440 Mhz.

One form of amplitude modulation is **Single sideband**. (T8A01)

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

The sideband normally used for 10 meter HF, VHF, and UHF single-sideband communications is **Upper sideband**. (T8A06)

A characteristic of single sideband (SSB) compared to FM is that **SSB signals have narrower bandwidth.** (T8A07)

The approximate bandwidth of a single sideband (SSB) voice signal is **3 kHz. (T8A08) #5**

The approximate bandwidth of a VHF repeater FM phone signal is **between 10 and 15 kHz**. **(T8A09) #3**

The approximate bandwidth of AM fast-scan TV transmissions is **about 6 MHz**. (T8A10)

The approximate maximum bandwidth required to transmit a CW signal is **150 Hz**. (T8A11)

The type of modulation most commonly used for VHF and UHF voice repeaters is **FM or PM**.(T8A04)

The type of modulation most commonly used for VHF packet radio transmissions is **FM or PM**. (T8A02)

The type of emission that has the narrowest bandwidth is **CW**. (T8A05)

A disadvantage of FM compared with single sideband is **only one signal can be received at a time.** (T8A12)

ELEMENT 8 GROUP B

Satellites normally transmit in FM, SSB or CW/data modes. Most have a beacon that transmits continually, normally in CW mode, sending out the ID and sometimes the health and status of the electronics for anyone to monitor. There are several tracking programs that show a map with the satellite position, elevation, altitude and frequency pair among other things. Remember these are repeaters. Unlike ground stations, they normally transmit in one band and receive in another. A U/V mode satellite has an uplink in the UHF band and downlink in the VHF band. With proper equipment you can monitor the satellite output as you are transmitting to make sure you are using the proper input power and frequency.

Satellites travel at several thousand miles per hour in a low earth orbit or LEO. Just like sound at high speed, radio waves have a Doppler shift as the satellite passes overhead so the frequency is always changing slightly. Another phenomenon is known as spin fading. The satellites are slowly rotating as they go so the antenna is always changing orientation. This causes changes in phasing (horizontal or vertical) and may put the antenna on the backside of the satellite. Satellite communications is very challenging and can be a lot of fun and very rewarding. How many people do you know that can talk to an astronaut on the International Space Station? With a Technician license, you can.

The mode of transmission commonly used by amateur radio satellites is:
SSB;
FM
CW/data
All of these choices are correct (T8B04)

A satellite beacon is **a transmission from a satellite that contains status information**. (T8B05)

The telemetry information typically transmitted by satellite beacons is **the health and status of the satellite.** (T8B01)

Anyone *may receive telemetry from a space station.* (T8B11)

Which of the following are provided by satellite tracking programs?
Maps showing the real-time position of the satellite track over the earth.
The time, azimuth, and elevation of the start, maximum altitude, and end of a pass.
The apparent frequency of the satellite transmission, including effects of Doppler shift.
All of these choices are correct (T8B03)

Inputs to a satellite tracking program are called the **Keplerian elements.** (T8B06)

The impact of using too much effective radiated power on a satellite uplink is **blocking access by other users.** (T8B02)

A good way to judge whether your uplink power is neither too low nor too high is **your signal strength on the downlink should be about the same as the beacon.** (T8B12)

The statement that a satellite is operating in mode U/V means the **satellite uplink is in the 70 centimeter band and the downlink is in the 2 meter band.** (T8B08)

With regard to satellite communications, Doppler shift is an **observed change in signal frequency caused by relative motion between the satellite and the earth station**. (T8B07)

Spin fading of satellite signals is caused by **rotation of the satellite and its antennas.** (T8B09)

The initials LEO tell you that an amateur **satellite is in a Low Earth Orbit.** (T8B10)

ELEMENT 8 GROUP C

Operating activities – Radio Direction Finding, or RDF, uses directional antennas to locate interference or jamming in Amateur radio. Most clubs have Fox Hunts every year to practice RDF and sharpen their skills. Another fun activity is contesting. Contesting involves contacting as many operators as you can in a specific time period. There are contests in different modes on different bands almost every week. The Internet Radio Linking Project, or IRLP, and Echolink use the Internet to connect repeaters together for wide area or long range communications using VOIP protocol through gateways. Once you register your call and provide proof of license, you can use your DTMF mike on your radio to access links all around the world.

The Internet Radio Linking Project (IRLP) **is a technique to connect amateur radio systems, such as repeaters, via the Internet using Voice Over Internet Protocol (VoIP).** (T8C08)

Voice Over Internet Protocol (VoIP) is **a method of delivering voice communications over the internet using digital techniques.** (T8C07)

Over the air access to IRLP nodes is accomplished **by using DTMF signals.** (T8C06)

An amateur radio station that is used to connect other amateur stations to the internet is **a gateway**. (T8C11)

Before you may use the EchoLink system **you must register your call sign and provide proof of license**. (T8C10)

The protocol that enables an amateur station to transmit through a repeater without using a radio to initiate the transmission is **Echolink**. (T8C09)

A method used to locate sources of noise interference or jamming is **radio direction finding.** (T8C01)

One item that would be useful for a hidden transmitter hunt is **a directional antenna**. (T8C02)

An operating activity that involves contacting as many stations as possible during a specified period is **contesting**. (T8C03)

A good procedure when contacting another station in a radio contest is to **send only the minimum information needed for proper identification and the contest exchange.** (T8C04)

A grid locator is **a letter-number designator assigned to a geographic location.** (T8C05)

ELEMENT 8 GROUP D

Automatic Packet Reporting System, or APRS, uses packet digital communications and GPS receivers to send automatic position reports from a mobile, to provide real time tactical data on a moving map. Packet digital transmissions include a check sum for error detection, a header with the station information and automatic repeat request (ARQ) for error correction. Digital Mobile Radio, or DMR, uses a digital protocol to time-multiplex two voice signals on a single channel. WSJT is a digital mode software suite that supports moon bounce, weak signal propagation, meteor scatter and several others. FT8 digital operates in low signal to noise conditions and is probably the most popular digital mode today. Broadband hamnet is an Amateur radio based Wi-Fi network for short-range communications.

Some digital communications modes are;
Packet radio;
IEEE 802.11;
JT65.;
All of these choices are correct. (T8D01)

The abbreviation "PSK" means **Phase Shift Keying**. (T8D06)

The following are included in packet radio transmissions;
A check sum that permits error detection;
A header that contains the call sign of the station to which the information is being sent;
Automatic repeat request in case of error**;**
All of these choices are correct (T8D08)

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

FT8 is a **digital mode capable of low signal-to-noise operation.** (T8D13)

The transmission mode indicated by the term "NTSC?" is **an analog fast scan color TV signal** (T8D04)

The following operating activities are supported by digital mode software in the WSJT suite;
Earth-Moon-Earth;
Weak-signal propagation beacons;
Meteor scatter;
All of these choices are correct (T8D10)

DMR (Digital Mobile Radio) **is a technique for time-multiplexing two digital voice signals on a single 12.5 kHz repeater channel.** (T8D07)

A "talkgroup" on a DMR repeater is **a way for groups of users to share a channel at different times without hearing other users on the channel .** (T8D02)

The data that can be transmitted by APRS includes;
GPS position data;
Text messages;
Weather data;
All these choices are correct. (T8D03)

One application of APRS (Automatic Packet Reporting System) is **providing real-time tactical digital communications in conjunction with a map showing the locations of stations.** (T8D05)

An Amateur Radio mesh network is **an amateur-radio-based data network using commercial Wi-Fi gear with modified firmware.** (T8D12)

CW is **another name for a Morse code transmission.** (T8D09)

End Of Element 8

Technician Class Study Guide

ELEMENT 9 GROUP A

Antennas and Feedlines

[2 Exam Questions - 2 Groups]

Verticals, dipoles and beams are the most common antennas that hams use. Dipoles and beams are normally horizontally polarized and verticals are usually multi-band and are vertically polarized. Since they radiate broadside to the antenna, the orientation determines polarization. Beams and Yagis are directional and concentrate their signal in one direction. You can make an antenna electrically longer by inserting a coil or inductor in the radiating portion. Low frequency antennas would be impractically large without coils to make them smaller. Handhelds are convenient to have but they use "rubber duck" antennas which aren't very efficient and don't work well inside of a metal vehicle. A good mobile antenna is designed to lower the radiation angle, which gives it gain over a reference antenna.

A half-wave dipole antenna radiates the strongest signal **broadside to the antenna**. (T9A10)

A simple dipole oriented parallel to the Earth's surface is a **horizontally polarized antenna**. (T9A03)

A beam antenna is an **antenna that concentrates signals in one direction.** (T9A01)

The type of antenna that offers the greatest gain is a **yagi**. (T9A06)

A disadvantage of the short flexible antenna supplied with most handheld radio transceivers, compared to a full-sized quarter-wave antenna is that **it has low efficiency**.(T9A04)

A disadvantage of using a handheld VHF transceiver with a flexible antenna inside a vehicle, is that **signal strength is reduced due to the shielding effect of the vehicle.** (T9A07)

Antenna gain is **the increase in signal strength in a specified direction compared to a reference antenna.** (T9A11)

The advantage of a 5/8 wavelength whip antenna for VHF or UHF mobile service is that **it has more gain than a 1/4 wavelength antenna.** (T9A12)

A type of antenna loading is **electrically lengthening by inserting inductors in radiating elements.** (T9A02)

To increase the resonant frequency of a dipole antenna you **shorten it**. (T9A05)

The approximate length, in inches, of a quarter-wavelength vertical antenna for 146 MHz is **19**. (T9A08)

300/F=WLm *39.4 /4 (Quarter wave)
300/146=2.05 2.05*39.4=80.95 80.95/4=20.2 inches

The approximate length, in inches, of a half-wavelength 6 meter dipole antenna is **112**. (T9A09)

WLm*39.4 /2 (Half wave)
6*39.4=236.4 236.4/2=118.2

ELEMENT 9 GROUP B

50 Ohm coax cable is the most commonly used cable for ham radio because it is affordable, easy to use and is easy to install. RG-58 is good for short cable runs but RG-8 has less loss for long runs. Air insulated cable has the least loss but it is expensive and requires many special considerations. RG-8 cable fittings are easy to install and work very well. The PL-259 is the standard fitting for HF and VHF. Type N fittings are typically used above 400 MHz. In any cable, as the frequency increases, the loss increases. A high SWR also increases signal loss so most hams use an antenna tuner to match the impedance of the antenna to the transceiver.

The most common impedance of coaxial cables used in amateur radio is **50 ohms**. (T9B02)

The benefit of a low SWR is **reduced signal loss**. (T9B01)

Coaxial cable is the most common feed line for amateur radio antenna systems because **it is easy to use and requires few special installation considerations**. (T9B03)

The electrical difference between RG-58 and RG-213 coaxial cable is **RG-213 cable has less loss at a given frequency**. (T9B10)

The major function of an antenna tuner (antenna coupler) is **to match the antenna systems impedance to the transceiver's output impedance**. (T9B04)

As the frequency of a signal in coaxial cable is increased, **the loss increases**. (T9B05)

A standing wave ratio (SWR) is **a measure of how well a load is matched to a transmission line.** (T9B12)

Erratic changes in SWR readings could be **a loose connection in the antenna or feed line**. (T9B09)

The type of feed line that has the lowest loss at VHF and UHF is **air-insulated hard line**. (T9B11)

PL-259 type coax connectors **are commonly used at HF and VHF frequencies**. (T9B07)

The connector most suitable for frequencies above 400 MHz is **a Type N**. (T9B06)

A source of loss in coaxial feed line is;
Water intrusion into coaxial connectors;
High SWR;
Multiple connectors in the line;
All of these choices are correct. (T9B08)

End Of Element 9

Technician Class Study Guide

ELEMENT 0 GROUP A

Electrical Safety

[3 Exam Questions - 3 Groups]

Safety is very important. You may be working with very high voltages and heavy objects on tall towers. RF energy can be very dangerous. A microwave oven uses RF energy to heat food. Low frequency RF is not quite as bad but can cause extreme injury if proper precautions are not taken. Don't assume that because it's unplugged it can't hurt you. Some power supplies have large capacitors that store energy and could give you an electrical shock. Grounding your station equipment is very important. Outside, make sure your tower and antennas are all bonded together with proper wire or strap and connected to a good ground rod. Inside, make sure you have all of your equipment grounded together with all of the protectors mounted on a metal plate connected to the same ground rod as the antenna system outside.

Use all 3-wire cords and plugs and use ground fault interrupter (GFI) circuit protectors. Always include protection in home built equipment and make sure all of the breakers and fuses have the proper rating for the circuit in case of overload. Using a larger fuse or breaker than the wiring is rated for can cause a fire. Remember that overcharging batteries or shorting the terminals can cause burns, fires and even explosions.

A safety hazard of a 12-volt storage battery is **shorting the terminals can cause burns, fire, or an explosion.** (T0A01)

Charging or discharging a battery too quickly **could cause overheating or out-gassing.** (T0A10)

Some health hazards presented by electrical current flowing through the body is:
It may cause injury by heating tissue;
It may disrupt the electrical functions of cells;
It may cause involuntary muscle contractions;
All of these choices are correct (T0A02)

A hazard that might exist in a power supply immediately after it is turned off is the **charge stored in filter capacitors.** (T0A11)

The purpose of a fuse in an electrical circuit is **to remove power in case of overload**. (T0A04)

In the United States, the black wire insulation in a three-wire 120 V cable is **Hot**. (T0A03)

A lightning arrester should be installed in a coaxial feed line
on a grounded panel near where feed lines enter the building. (T0A07)

With all external ground rods or earth connections you should **bond them together with heavy wire or conductive strap**. (T0A09)

A fuse or circuit breaker should be installed in a 120V AC power circuit **in parallel with the hot conductor only.** (T0A08)

A 5 amp fuse should never be replaced with a 20-ampere fuse because **excessive current could cause a fire.** (T0A05)

A precaution that should be taken when measuring high voltages with a voltmeter is to **ensure that the voltmeter and leads are rated for use at the voltages to be measured.** (T0A12)

A good way to guard against electrical shock at your station is:
Use three-wire cords and plugs for all AC powered equipment;
Connect all AC powered station equipment to a common safety ground;
Install mechanical interlocks in high-voltage circuits;
All of these choices are correct (T0A06)

ELEMENT 0 GROUP B

When working on a tower, always wear proper safety gear. Hard hats, safety glasses and a climbing harness are all very important. Always work as a team and **NEVER** climb a tower alone. Always try to use a gin pole to lift sections of tower to the top and always use a safety wire through guy wire turnbuckles to prevent loosening. Look out for and stay clear of all power lines. If there are lines in the area, make sure that if the tower falls over, nothing will come within at least ten feet of them and never connect any antenna or tower equipment to a utility pole. Always check local electrical codes when installing tower equipment. When grounding tower equipment, make sure all connections are short, direct and avoid sharp bends. Never climb a crank-up tower unless it is locked into place.

When climbing an antenna tower it is required to;
Have sufficient training on safe tower climbing techniques;
Use appropriate tie-off to the tower at all times;
Always wear an approved climbing harness;
All these choices are correct. (T0B02)

***Is it* NEVER** *safe to climb a tower without a helper or observer.* (T0B03)

An important safety precaution to observe when putting up an antenna tower is to **look for and stay clear of any overhead electrical wires.** (T0B04)

The minimum safe distance from a power line to allow when installing an antenna is **enough so that if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power wires.** (T0B06)

The purpose of a safety wire through a turnbuckle used to tension guy lines is to **prevent loosening of the turnbuckle from vibration.** (T0B05)

Grounding requirements for amateur radio towers or antennas **are established by local electrical codes.** (T0B11)

A proper grounding method for a tower is to use **separate eight-foot long ground rods for each tower leg, bonded to the tower and each other.** (T0B08)

When installing grounding conductors used for lightning protection, **sharp bends must be avoided.** (T0B10)

A good practice when installing ground wires on a tower for lightning protection is to **ensure that connections are short and direct.** (T0B01)

An important safety rule to remember when using a crank-up tower is **this type of tower must not be climbed unless retracted or mechanical safety locking devices have been installed.** (T0B07)

You should avoid attaching an antenna to a utility pole because **the antenna could contact high-voltage power lines.** (T0B09)

ELEMENT 0 GROUP C

Radiation exposure is a big thing with the FCC in the last few years. It's important to understand what it is, how to measure it and how to avoid it. The FCC OET bulletin 65 helps calculate RF exposure. You can also use computer modeling and field strength meters to make field measurements. Once you check for compliance, you only need to re-evaluate when you make equipment changes. After checking your compliance, keep these records in your station file in case the FCC wants to see it. The Maximum Permissible Exposure (MPE) varies with frequency. 3 MHz has the highest MPE and it drops to it's lowest at 30 MHz. It starts increasing again at about 300 MHz so from 30 to 300MHz has about the lowest MPE.

The radiation from radio signals is **non-ionizing radiation.** (T0C01)

RF radiation differs from ionizing radiation (radioactivity) because it **does not have sufficient energy to cause chemical changes in cells and damage DNA.** (T0C12)

A hazard created by touching an antenna during a transmission is **RF burn to the skin.** (T0C07)

One frequency that has the lowest value for the Maximum Permissible Exposure limit is **50 MHz.** (T0C02)

The allowable power density for RF safety change if duty cycle changes from 100 percent to 50 percent is **it increases by a factor of 2**. (T0C03)

Exposure limits vary with frequency because **the human body absorbs more RF energy at some frequencies than at others.** (T0C05)

The factors that affect the RF exposure of people near an amateur station antenna are;
Frequency and power level of the RF field;
Distance from the antenna to a person;
Radiation pattern of the antenna**;**
All of these choices are correct (T0C04)

The actions an amateur operator might take to prevent exposure to RF radiation is **relocate antennas.** (T0C08)

The person responsible for ensuring that no person is exposed to RF energy above the FCC exposure limits is **the station licensee.** (T0C13)

Which of the following is an acceptable method to determine that your station complies with FCC RF exposure regulations?
A. By calculation based on FCC OET Bulletin 65
B. By calculation based on computer modeling
C. By measurement of field strength using calibrated equipment
D. All of these choices are correct (T0C06)

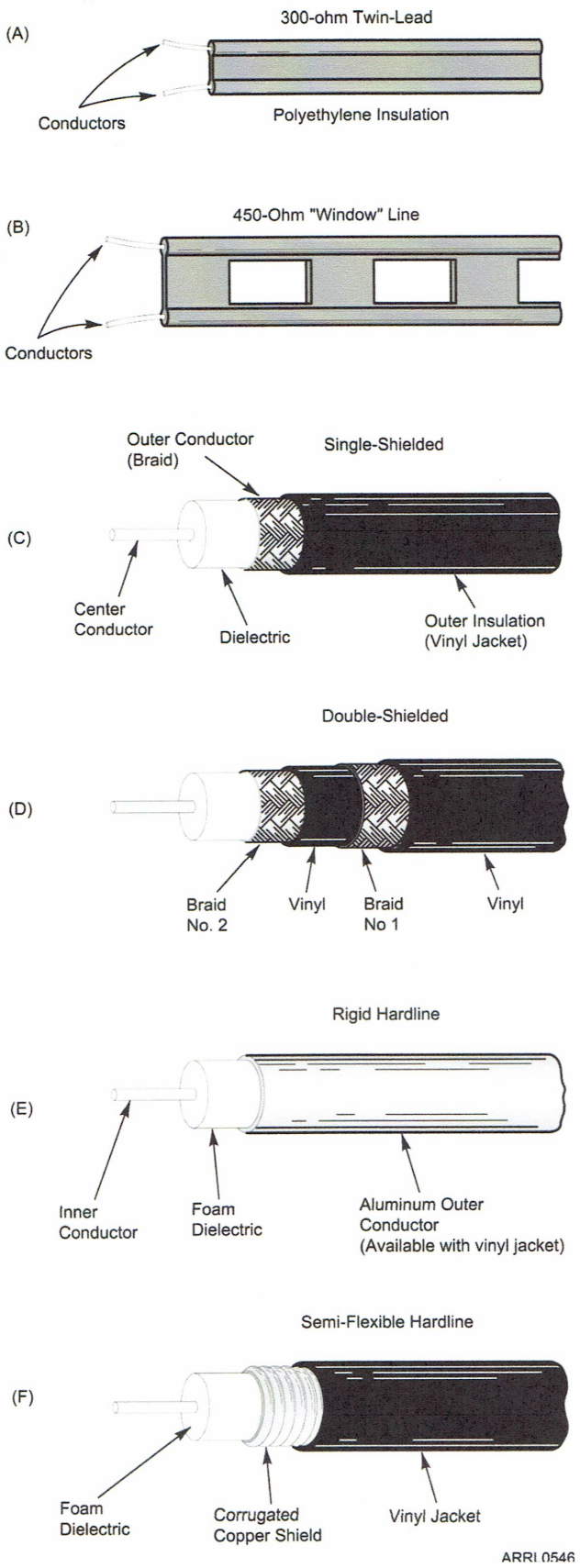
You can make sure your station stays in compliance with RF safety regulations by **re-evaluating the station whenever an item of equipment is changed.** (T0C09)

The definition of duty cycle during the averaging time for RF exposure is **the percentage of time that a transmitter is transmitting.** (T0C11)

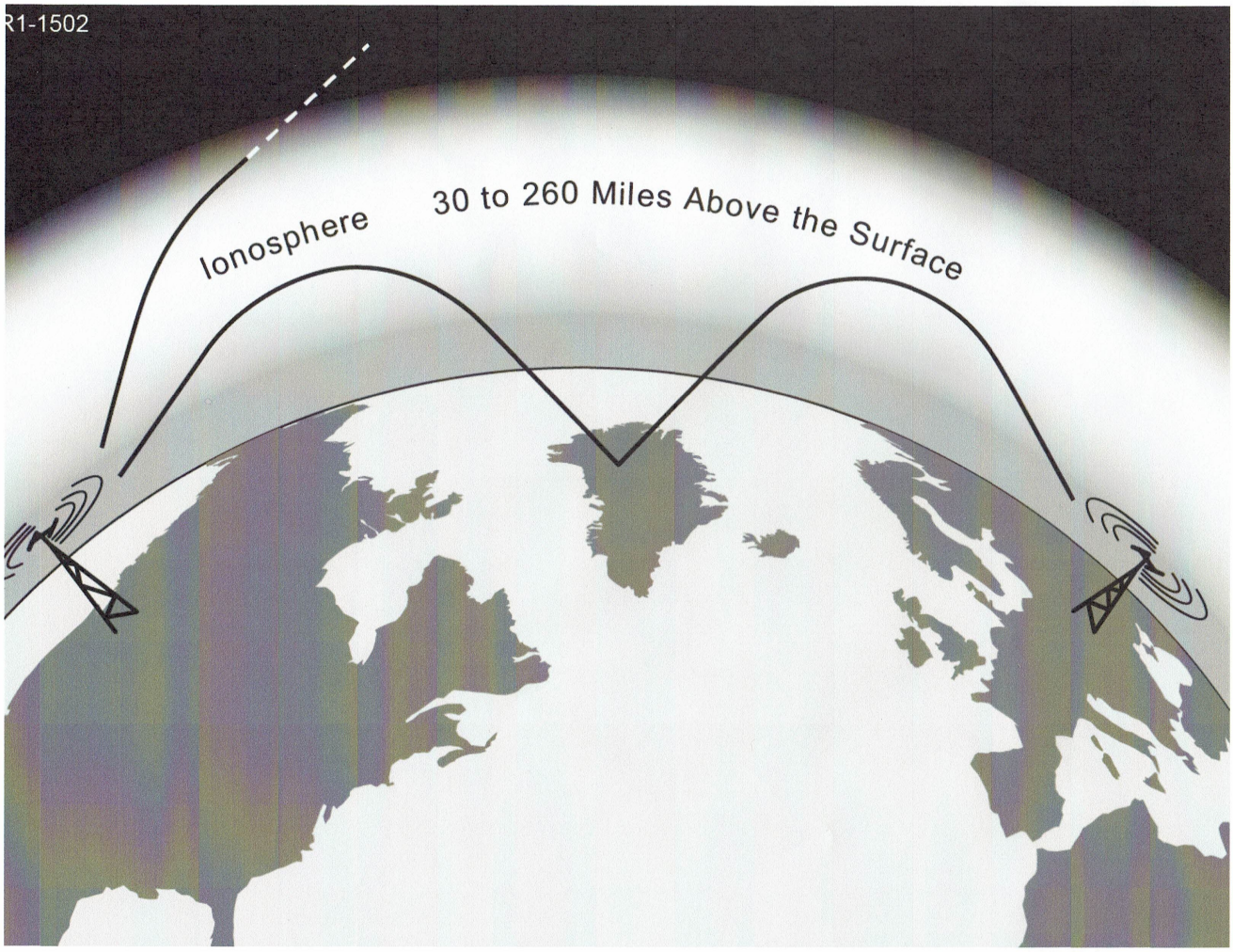
Duty cycle is one of the factors used to determine safe RF radiation exposure levels **because it affects the average exposure of people to radiation**. (T0C10)

End Of Element 0

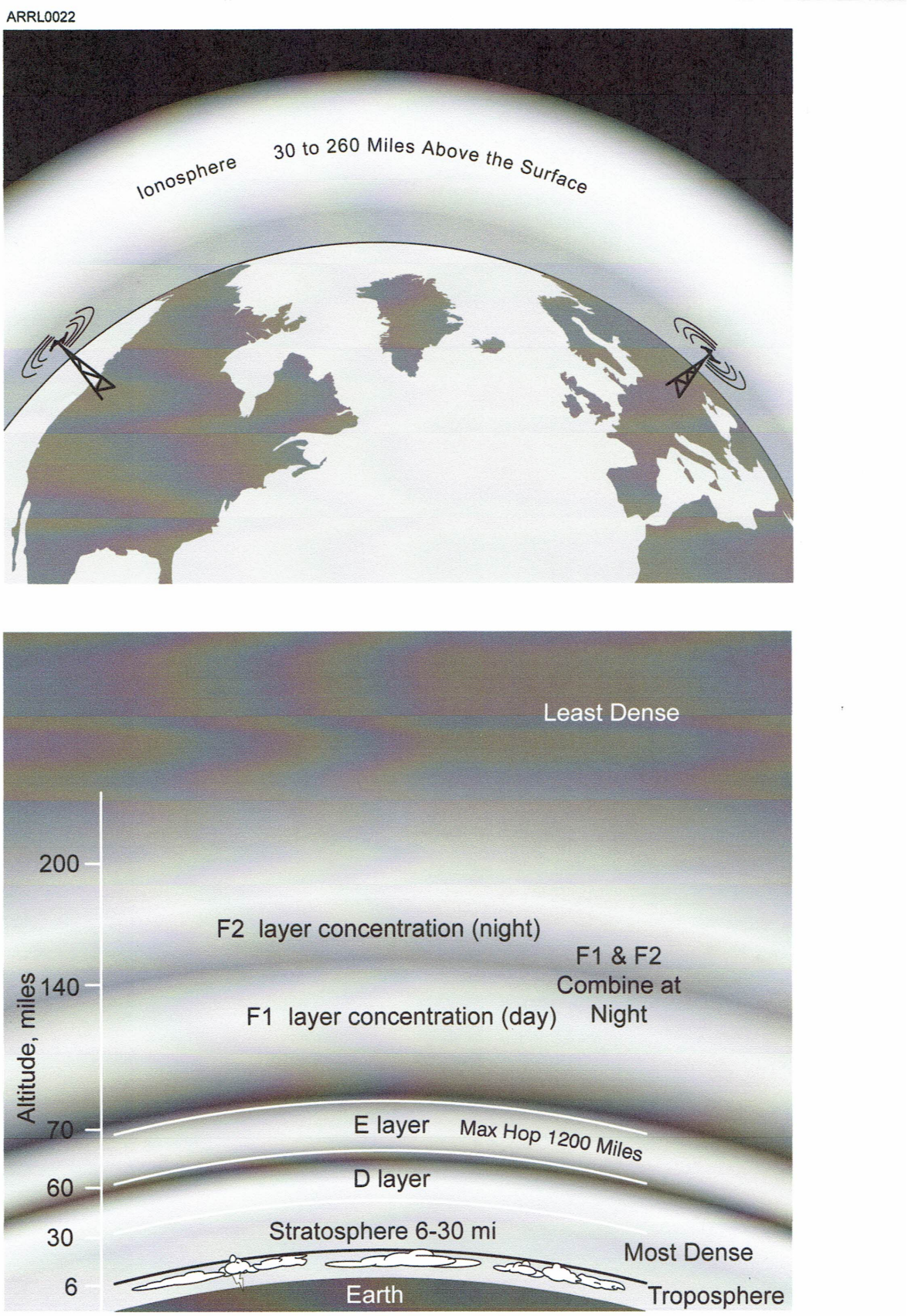
Transmission Lines



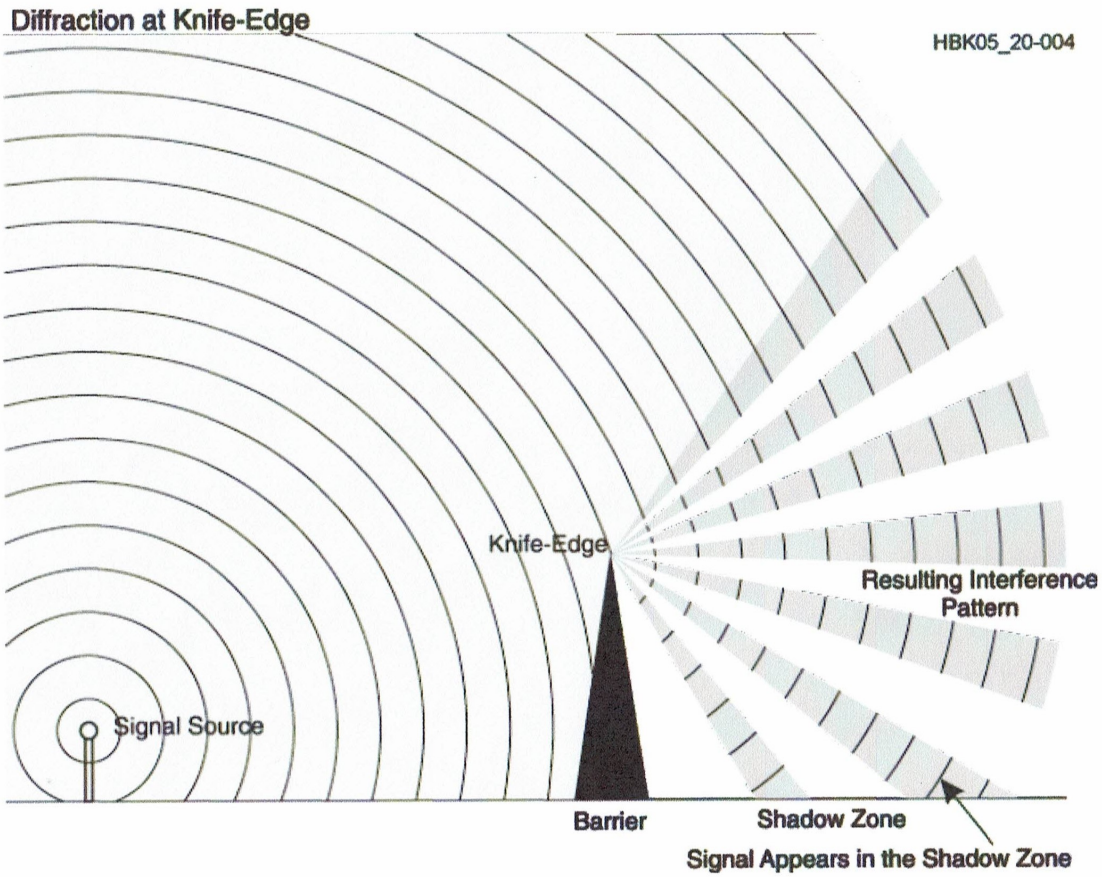
Basic Ionosphere



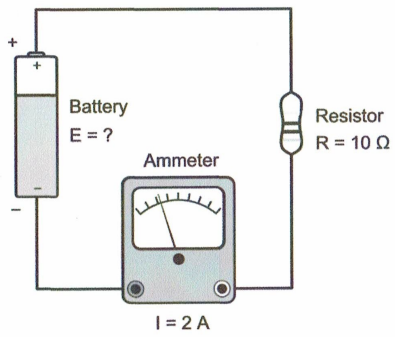
Ionosphere Conditions



Knife Edge Diffraction



Test Meters



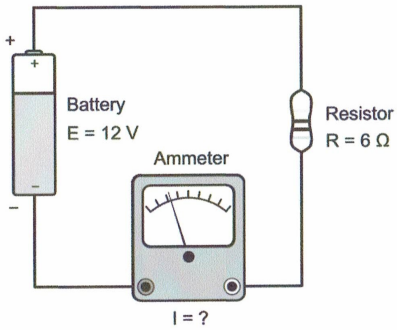
Given: I = 2 Amperes
R = 10 Ohms

Find: E (voltage)

$E = I \times R = 2 \times 10 = 20$ Volts

Voltage Equals 20 Volts

ARRL0006

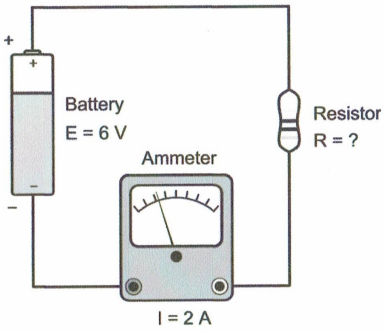


Given: E = 12 Volts
R = 6 Ohms

Find: I (current)

$I = \frac{E}{R} = \frac{12}{6} = 2$ Amps

Current Equals
2 Amperes



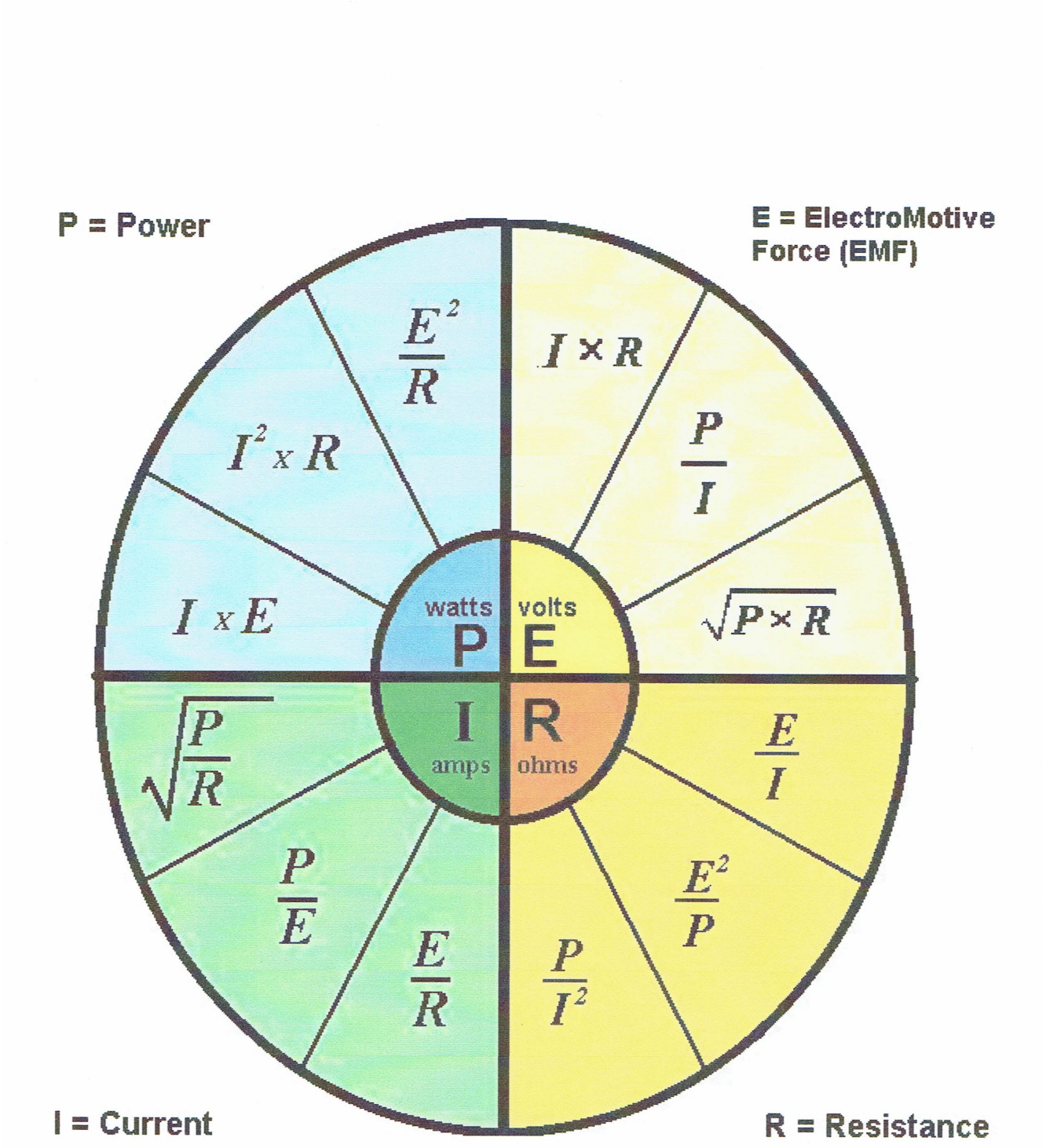
Given: E = 6 Volts
I = 2 Amperes

Find: R (resistance)

$R = \frac{E}{I} = \frac{6}{2} = 3$ Ohms

Resistance Equals
3 Ohms

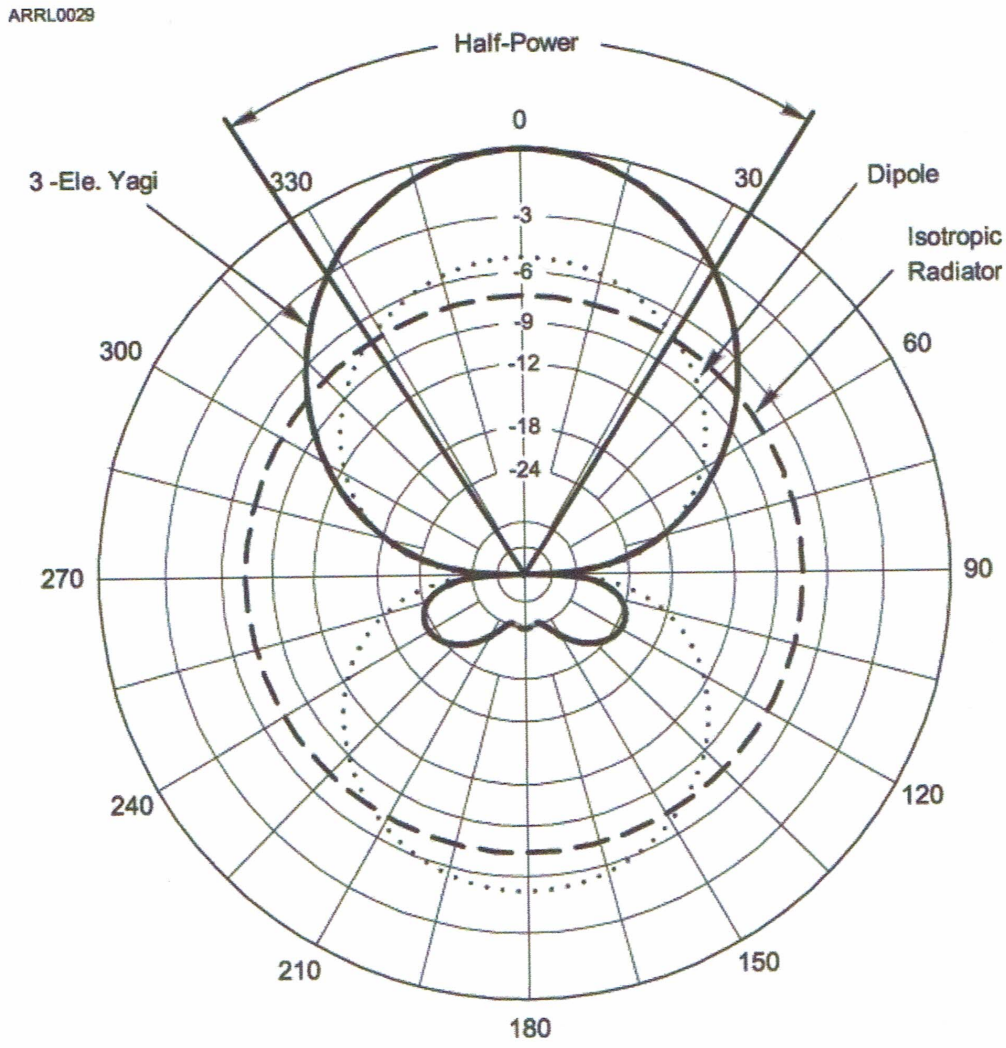
PIRE Chart


P = Power
E = ElectroMotive Force (EMF)
$\frac{E^2}{R}$
$I \times R$
$\frac{P}{I}$
$I^2 \times R$
$I \times E$
watts
P
volts
E
$\sqrt{P \times R}$
$\sqrt{\frac{P}{R}}$
I
amps
R
ohms
$\frac{E}{I}$
$\frac{P}{E}$
$\frac{E^2}{P}$
$\frac{E}{R}$
$\frac{P}{I^2}$
I = Current
R = Resistance

Power Gain Chart

POWER GAIN IN dB							
dB GAIN			POWER FACTOR	dB GAIN			POWER FACTOR
1	=	X	1.26	11	=	X	12.60
2	=	X	1.60	12	=	X	15.80
3	=	X	2.00	13	=	X	20.00
4	=	X	2.50	14	=	X	25.10
5	=	X	3.00	15	=	X	31.60
6	=	X	4.00	16	=	X	40.00
7	=	X	5.00	17	=	X	50.10
8	=	X	6.30	18	=	X	63.10
9	=	X	8.00	19	=	X	80.00
10	=	X	10.00	20	=	X	100.40

Antenna Gain Chart



THE AMERICAN RADIO RELAY LEAGUE

RADIOGRAM

VIA AMATEUR RADIO

NUMBER	PRECEDENCE	HX	STATION OF ORIGIN	CHECK	PLACE OF ORIGIN	TIME FILED	DATE

TO

TELEPHONE NUMBER

THIS RADIO MESSAGE WAS RECEIVED AT

AMATEUR STATION _____ PHONE _____

NAME _____

STREET ADDRESS _____

CITY, STATE, ZIP _____

FROM	DATE	TIME	TO	DATE	TIME
REC'D			SENT		

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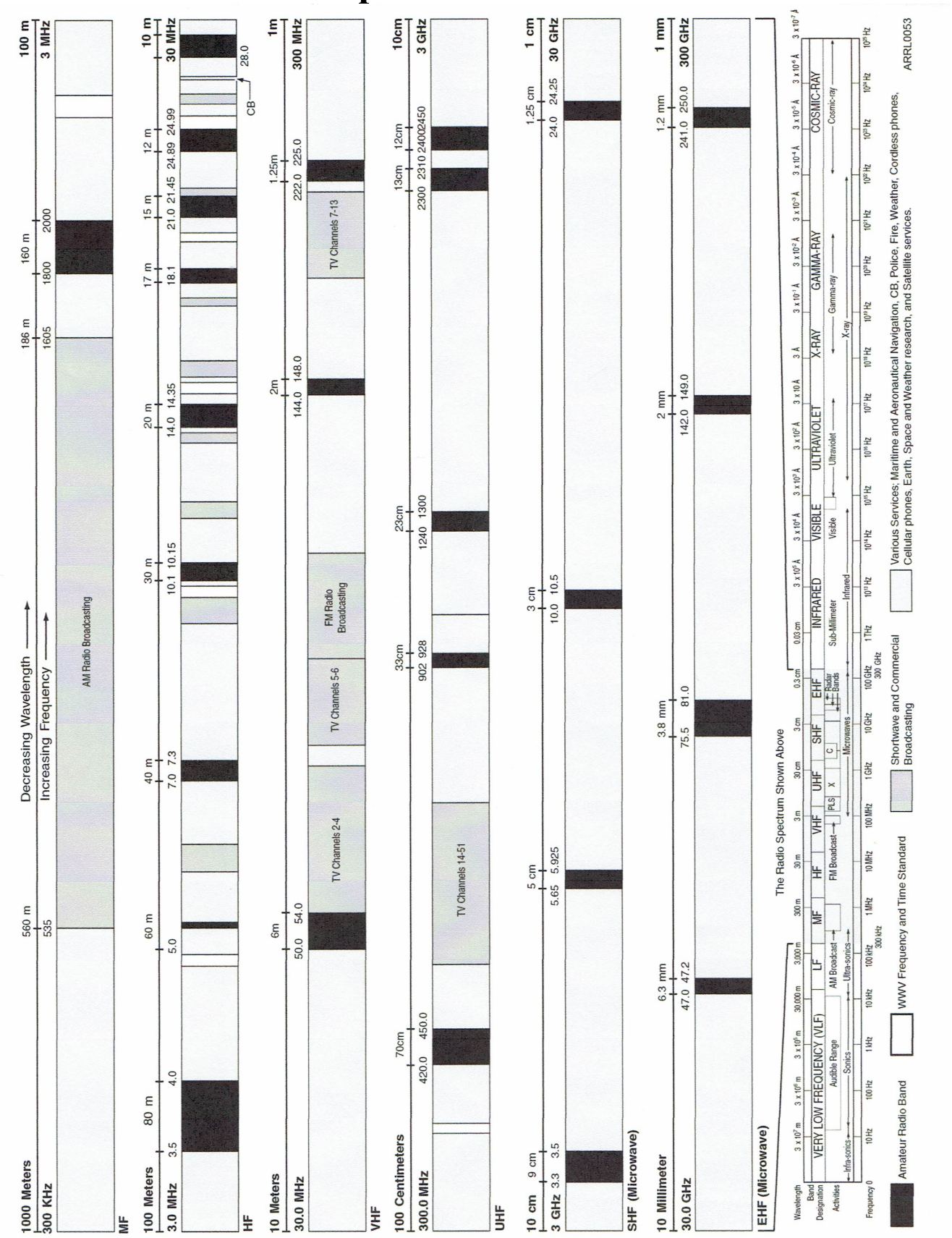
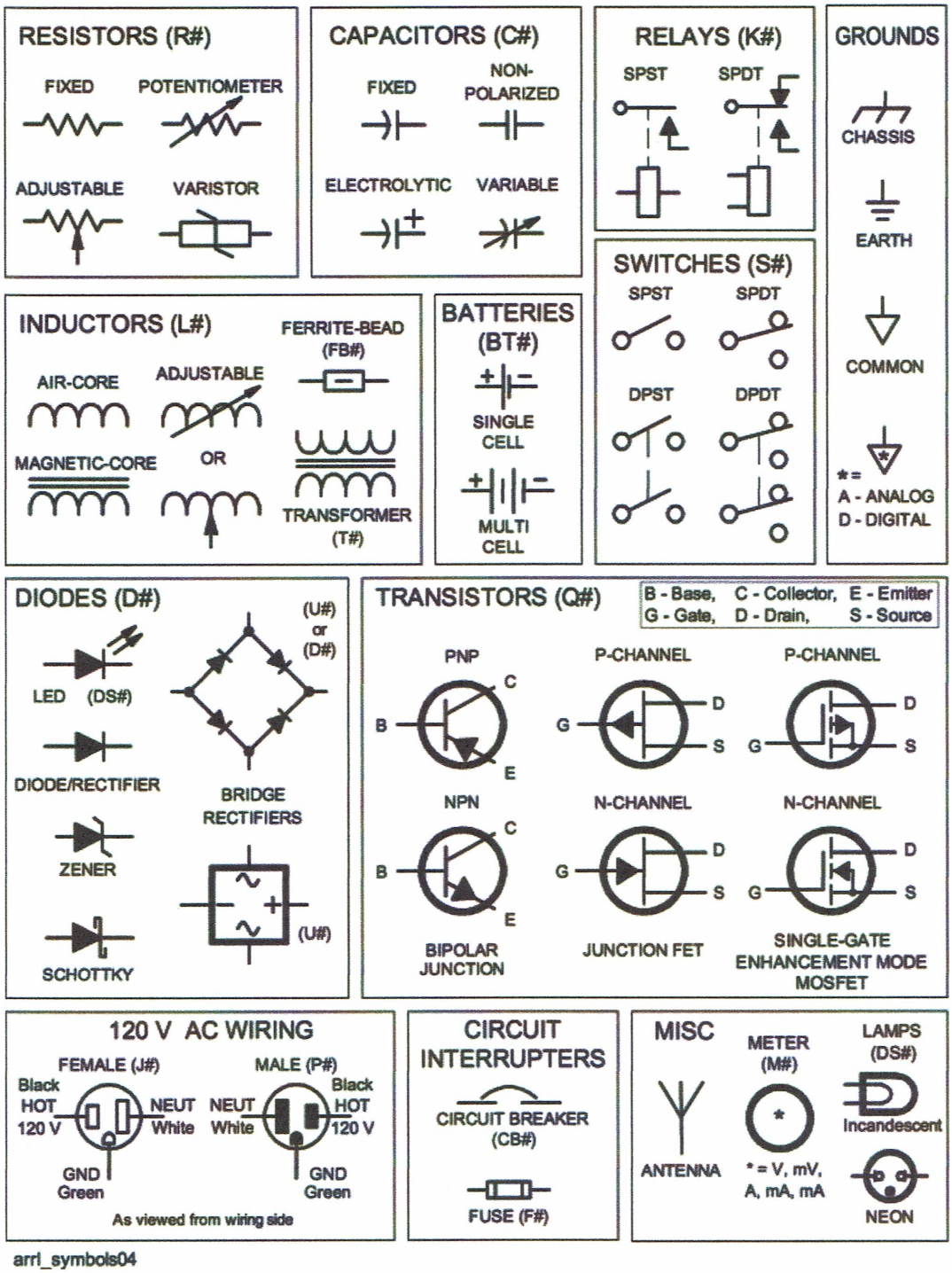
Spectrum Chart



Schematic Symbols Used in Circuit Diagrams

Labeling conventions:
is a sequential number. **(X#)** is the component designator. Examples - C3, L11, R8, Q3



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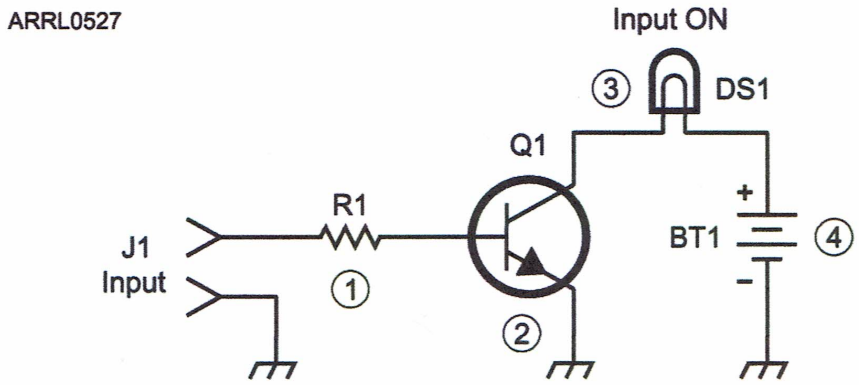
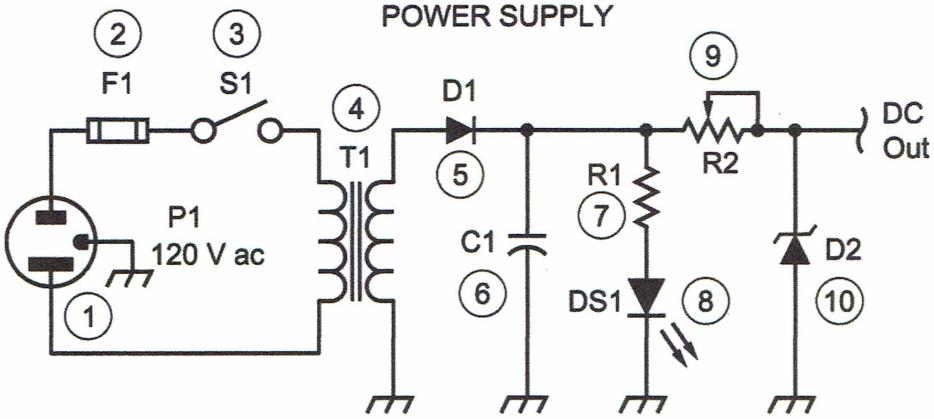
Element 2 Exam Diagrams



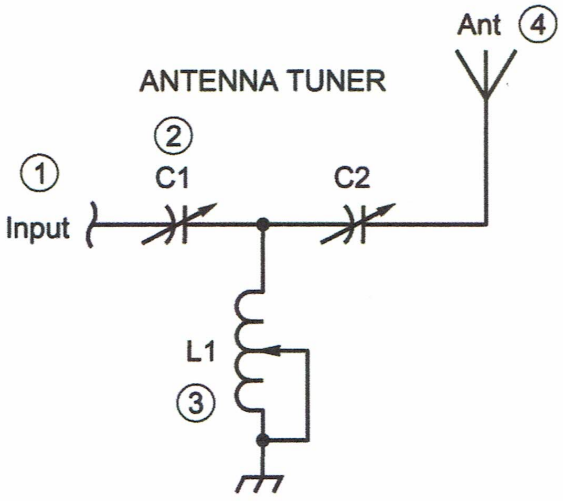
Exam Diagram T1

(A)



Exam Diagram T2

(B)



Exam Diagram T3

(C)