Technician Study Sheet

To prepare for the class, read through the following four pages in advance. If you know the material in these pages, you will probably be able to pass the exam.. Information is on these pages because it can be memorized and addresses multiple questions in the pool. We recommend using a tool to drill the questions and take practice tests, like hamstudy.com,Ham Academy from **http://www.ah0a.org,** and others.

Identification

All stations must identify themselves with their FCC callsign every 10 minutes while talking and at the end of a conversation. An “unidentified transmission” is illegal. There is no requirement to ID at the beginning, however it is often done to be courteous to other operators.. ID is done in the mode of the transmission (Exception: voice mode may ID in voice or in Morse Code (CW) at <20 WPM).

License Period

An amateur license is valid for 10 years. It can be renewed no earlier than 90 days in advance. There is a two year renewal grace period during which time the license is not valid but can be renewed with no examination required. Transmitting during the grace period is not allowed.

Good Amateur Practices

The radio spectrum is a shared resource and the FCC rules are largely based on “play nicely with others”. Good Amateur Practice is exactly that. They include “listen before transmitting” to insure the frequency isn’t already being used. If you want to break into a conversation in progress, you simply give your callsign between exchanges, the word “break” is only used to indicate emergency traffic. Additionally, Amateur Radio also cannot compete with commercial services so there is no broadcasting, business or music allowed (music can only be transmitted as incidental to a Space Shuttle/ISS rebroadcast).

Technician Class Frequency Privileges (1500 watt PEP max)

These are the frequencies allocated for us to Technician class operators after passing the written (element 2) exam. There is an inverse proportional relationship between frequency and wavelength. Longer wavelengths have lower frequencies. There are several frequency to wavelength conversion questions using the formula:.

$$\text{Wavelength(meters)} = \frac{300}{\text{Frequency(MHz)}}$$

6 meters	50-54 MHz
2 meters	144-148 MHz
1.25 meters	222-225 MHz - (219-220 MHz point-to-point digital links)
70 centimeters	420-450 MHz - (435-438 MHz satellite sub-band)
23 centimeters	1240-1300 MHz

Bands are organized with narrow modes (CW) near the bottom, voice at the top.

Repeater Frequency Separation (Split)

Repeaters are often placed on hilltops to extend the range of mobile and portable stations (handhelds). They listen on one frequency and simultaneously retransmit on another. The difference between transmit and receive frequencies is called “split” and varies for each band. All new radios know the split for each band but older units may not.

Batteries

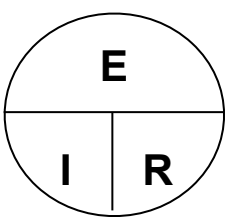
There are a number of common battery types currently available. The old Carbon-Zinc batteries have been largely replaced by alkaline and rechargeables. Alkaline batteries have good energy density but are non-rechargeable and produce 1.5 volts per cell. Rechargeable batteries evolved from Nickel Cadmium (NiCd) to Nickel Metal Hydride (NiMH) to Lithium Ion (LiIon) and beyond. NiMH is 1.2 volts per cell. LiIon is normally 3.6v/cell. LiIon batteries store more energy than NiMH and are more expensive. Lead Acid batteries are also fairly common.

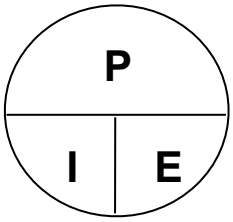
Frequencies

Radios and telephones are both designed to carry Voice Frequencies between 300-3000 Hertz. Radio Waves generally begin at a range above human hearing (20,000 Hertz

Ohm's Law and Power Formulas

The circles below are designed as a memory tool to help you remember the formulas. The first circle is Ohm's law. To use them, simply cover the value you want and solve remaining equation. To solve for E (voltage or Electromotive force), cover it up and multiply current in amperes times resistance in ohms. To solve for resistance, cover R and divide voltage in volts by current in amperes. All the formulas are listed below. Blank paper is provided for the test and participants are allowed to write down whatever they need.





I = Current in Amperes
R = Resistance in Ohms
P = Power in Watts
E = Voltage in Volts

NOTE: the conventional engineering notation for volts is "E". This pool may use volts as "V" to improve clarity.

Cover the value you need and divide or multiply the remaining values as appropriate.

Examples:

E = I x R I = E / R R = E / I

P = I x E I = P / E E = P / I

Measuring Units

These are the basic units of measurement of these values. In our usage, some measurements are often expressed as large or small units. Amperes are large and are often found as MilliAmpere or MicroAmpere. Ohms are small, so KiloOhms or MegaOhms are common.

Frequency	**Hertz**	Resistance	**Ohm**
Current	**Ampere**	Power	**Watt**
Electromotive Force	**Volts**		

Unit Conversions

These are basic metric conversions. Notice they involve moving the decimal place some number of digits right or left. 1,000 Kilohertz = 1 Megahertz. Several common metric prefixes are shown below.

Kilo	10^{3}	1,000	Milli	10^{-3}	0.001
Mega	10^{6}	1,000,000	Micro	10^{-6}	0.000001
Giga	10^{9}	1,000,000,000	Pico	10^{-12}	0.000000000001

Radio Modes

The simplest radio signal is just a single frequency. By turning that radio wave on and off, it's possible to send morse code (CW). Amplitude Modulation is the simplest voice modulation scheme but it's not very efficient because it has two identical (redundant) sidebands with the voice information and the radio carrier that doesn't contain any information. Amateur radios often use Single Sideband (SSB) transmissions that are spectrally (space) and power efficient by removing one of the AM sidebands and the carrier before transmission. This leaves either the upper or lower sideband (USB/LSB). Convention dictates that lower sideband (LSB) signals are used below 10MHz and upper sideband (USB) is used above 10MHz.

Amplitude Modulation (AM), Single Sideband (SSB) and Code (CW) are all related.
Upper Sideband (USB) is used on VHF frequencies and above 20m.

Bandwidth

Bandwidth determines how much spectrum a signal occupies. Narrower signals tend to be more efficient and can have longer range. The "radio mode" determine the bandwidth of your signal.

Radio Functions

This section refers to actual knobs and buttons on an amateur radio (and many others). Up/Down buttons on the radio or microphone allow tuning different frequencies or memory channels. Shift allows changing the transmit and receive frequencies for working through repeaters. The Noise Blanker is designed to quiet ignition (pulse-type) noise. The Function or (F) key allows accessing secondary functions on many radios. Tuning is accomplished via the tuning knob known as VFO (Variable Frequency Oscillator) knob, Up/Down buttons or a keypad on the radio. The Step or Tune Step (TS) button allows quick or fine tuning by adjusting the tuning increment. Receiver Incremental Tune (RIT) allows fine-tuning of the receiver without affecting the transmit frequency. The Squelch function is designed to keep the radio quiet when there is no signal present.

Up/Down change frequency/memory	Tune via **keypad** or **VFO**
Shift changes receive/transmit offset	**Step (TS)** adjusts tune increments
Noise Blanker (NB) quiets ignition noise	**RIT** – Receiver Incremental Tune
Function (F) key accesses alternate key actions/ functions	**Squelch** quiets receiver

Q Signals and Pro-signs

Q Signals are shorthand created for Morse code operators. Many of these have found their way into voice operations as well. The bolded items are asked specifically (the others are for your information).

QRM	**Man-made noise**	QRN	Atmospheric noise
QSY	**Change frequency**	QTH	Current/home location
QSB	Atmospheric fading	QSL	Confirmation of report
CQ	Calling any station	DX	Distant stations only

SWR

SWR stands for Standing Wave Ratio and is a measure of how well the antenna is matched to the radio. A 1:1 SWR means all the radio output power is being transferred to the antenna and is ideal. A high SWR can overheat the radio so most radios have circuitry that lowers output levels as SWR increases.

Antenna Lengths

The dipole is the basic “T” shaped antenna, similar to what is supplied with FM stereos that tack to the wall. The top of the antenna is a half wavelength for the desired frequency and the feed line (coax) can be any length. The formula for calculating the top length is shown. There are a number of vertical antenna designs but the ¼ wave is the basic design. Notice the formula for this provides a number exactly half the length of the dipole.

There is also mention of yagis, quads and dish antennas. All of these designs are very directional. Yagis have multiple elements like TV antennas. Quads are big loops and can also be made into multi-element antennas. These multi-element designs are generally referred to as “beams”.

RF Safety

Surprisingly low voltages and currents can cause injury or death in the proper combination. The FCC is also concerned about human exposure to RF fields. The FCC has defined maximum transmitted power levels allowed before a station evaluation is required. Station evaluation is required to identify RF exposure to humans nearby. Voltage as low as 30V can be dangerous and current as low as 100mA can be deadly.

See the RF Safety Calculator at arrl.org.

Miscellaneous tidbits
The Federal Communications Commission (FCC) regulates radio use in the US, the International Telecommunication Union (ITU) organizes radio operations internationally.
Valid US callsigns start with A, K, N or W (WANK) and have 1-2 letters, 1 digit (0-9), and 1-3 letters. They are referred to by the number of letters in the "prefix" and "suffix".. For example, KA2BCD is called a 2x3, N9MNO, W4APR (1x3); AB9CD (2x2); AC6V (2x1), N6B (1x1)

New calls are issued sequentially, vanity calls are available to any licensed ham, but the shorter calls are reserved for the upgrade classes of General and Amateur Extra.

License Period – 10 years with 2 year grace. You can renew 90 days before expiration.

A Club must have at least 4 members to be eligible for club license.

Good Amateur Practices
Listen before transmitting.
Just transmit callsign to break into a conversation.
Amateur Radio allows no broadcasting, no music transmissions, no codes/ciphers intended to obscure a message, no swearing, no ethnic/racial slurs and no business.

Filters
Spurious emissions/harmonics (your problem) require low-pass filter at transmitter.
RF/frontend/fundamental overload (their problem) requires high-pass filter at TV receiver.

Repeater Frequency Separation (Split)	
2 meter band	600 kHz
70 centimeter band	5.0 MHz

Bandwidth	
PSK31 signal	31 Hz
SSB signal	2-3 kHz
FM signal	5-15 kHz
TV (NTSC) signal	6 MHz

SWR of 1:1 is perfect and near 2:1 transmitters generally start reducing power output.

Antenna Lengths

Half Wave Dipole $L = \frac{5600}{F\ (MHz)}$ Where: L = Length in Inches, F = Frequency in MHz

Quarter Wave Vertical $L = \frac{2800}{F\ (MHz)}$

Voice Frequency Bandwidth is typically 300-3000Hz and Radio Waves are >20,000Hz.

AMSAT is responsible for US amateur radio satellites.

Emergency Communications
RACES serves government agencies and ARES serves non-government groups.
Messages contain name of sender in the preamble, no more than 25 words and a check.