

Technician Study Sheet Instructions

To prepare for the class, read through the following four pages in advance and memorize as much as possible. The first two pages are overview and summary information extracted from the question pool, followed by a two page Study Sheet with helpful mnemonics and formulas. Information is on these pages because it can be memorized and addresses multiple questions in the pool. You may also find it very helpful to use Ham Academy to drill the questions and/or take practice tests. Ham Academy runs on most browsers and can be downloaded from <http://www.ah0a.org/HA4> for free. You can take online practice tests at <http://www.grz.com/p/testing.pl>.

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 shown.

Identification

All operators must identify themselves with their FCC callsign every 10 minutes while talking and at the end of a transmission or it is an illegal "unidentified transmission". There is no requirement to ID at the beginning – it only helps the other operator. CW (morse code) at less than 20 words per minute is always an acceptable way to ID.

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 loss of privileges (no retest). 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).

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.

Bandwidth

Bandwidth determines how much spectrum a signal occupies. Narrower signals tend to be more efficient and have longer range.

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.

Batteries

There are a number of common battery types currently available. The old Carbon-Zinc batteries have been largely replaced by Alkaline. Alkaline batteries have great life but both are non-rechargeable and run about 1.5 volts per cell. Rechargeable batteries evolved from Nickel Cadmium (NiCd) to Nickel Metal Hydride (NiMH) to Lithium Ion (Lion). NiCd and NiMH both share the same 1.2 volts per cell but don't have nearly the battery life as Lion batteries.

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.

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 at 20,000 Hertz

Measuring Units

These are the basic units of measurement of these values. These 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.

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.

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.

Q Signals

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.

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 $\frac{1}{2}$ 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. The station evaluation is used to identify RF exposure to humans nearby.

Technician License Examination - Study Sheet

Technician Class Frequency Privileges (1500 watt PEP max)

| | |
|-----------------------|--|
| 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 subband) |
| 23 centimeters | 1240-1300 MHz |

Bands are organized with narrow modes (CW) near the bottom.
$$\text{Wavelength(meters)} = \frac{300}{\text{Frequency(MHz)}}$$

Valid US callsigns start with A, K, N or W (WANK) and contain 1 digit (0-9).

The Federal Communications Commission (FCC) regulates radio use in the US, the International Telecommunication Union (ITU) organizes radio operations internationally.

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

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

Identification - Must ID every 10 minutes and at the end of transmission – CW <20WPM OK

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.

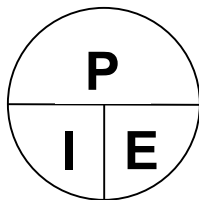
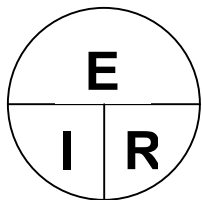
Repeater Frequency Separation (Split)

| | |
|--------------------|---------|
| 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 |

Ohm's Law and Power Formulas



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

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

Examples:

$$E = I \times R$$

$$I = E / R$$

$$R = E / I$$

$$P = I \times E$$

$$I = P / E$$

$$E = P / I$$

Batteries

Lithium Ion (Lilon) batteries offer the best battery life.
 Nickel Cadmium (NiCd) “nominal voltage” is 1.2 volts per cell.

Unit Conversions

| | | | | | |
|------|-----------------|-----------|-------|------------------|----------|
| Mega | 10 ⁶ | 1,000,000 | Micro | 10 ⁻⁶ | 0.000001 |
| Kilo | 10 ³ | 1,000 | Milli | 10 ⁻³ | 0.001 |

Voice Frequencies are 300-3000Hz and Radio Waves are >20,000Hz.

Measuring Units

| | | | |
|---------------------|---------------|------------|-------------|
| Frequency | Hertz | Resistance | Ohm |
| Current | Ampere | Power | Watt |
| Electromotive Force | Volts | | |

Radio Functions

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

Radio Modes

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

AMSAT is responsible for most amateur radio satellites.

Q Signals

| | |
|-------------------------------|-----------------------------------|
| QRM Man-made noise | QRN Atmospheric noise |
| QSY Change frequency | QTH Current/home location |
| QSB Atmospheric fading | QSL Confirmation of report |

CQ means calling any station. Respond with *station callsign* (this is) *your callsign*.

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.

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

Antenna Lengths

| | | | |
|-----------------------|------------------------------------|--------|-------------------------------|
| Half Wave Dipole | $L = \frac{5600}{F \text{ (MHz)}}$ | Where: | $L = \text{Length in Inches}$ |
| | | | $F = \text{Frequency in MHz}$ |
| Quarter Wave Vertical | $L = \frac{2800}{F \text{ (MHz)}}$ | | |

RF Safety

Voltage as low as 30V can be dangerous and current as low as 100mA can be deadly.
 Greater than 50 watts PEP at the antenna on VHF and up requires a station evaluation.