



# The Radio Merit Badge



## RADIO

**Lead Instructors:**

Yul, WA5YUL

Gerry, N2GJ

Ed, KC2LM





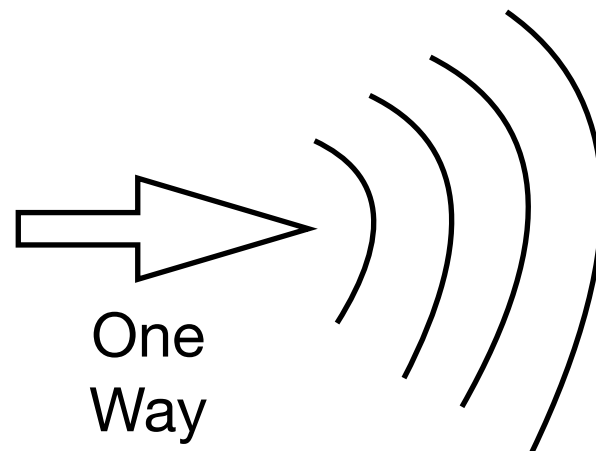
# The Radio Merit Badge

## Requirement: #1 (a & b)

### 1. Explain what radio is. Then discuss the following:

- (a) The differences between broadcast radio and hobby radio
- (b) The differences between broadcasting and two-way communications

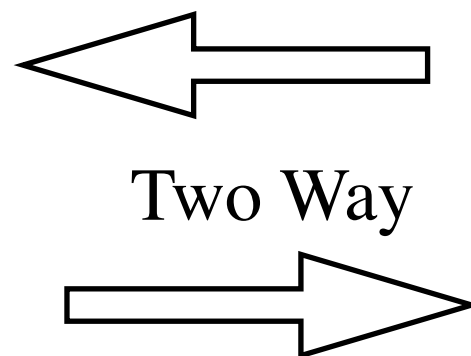
Broadcast Radio Station, 50,000 watts



Receivers  
at Home



Hobby Radio 100 watts







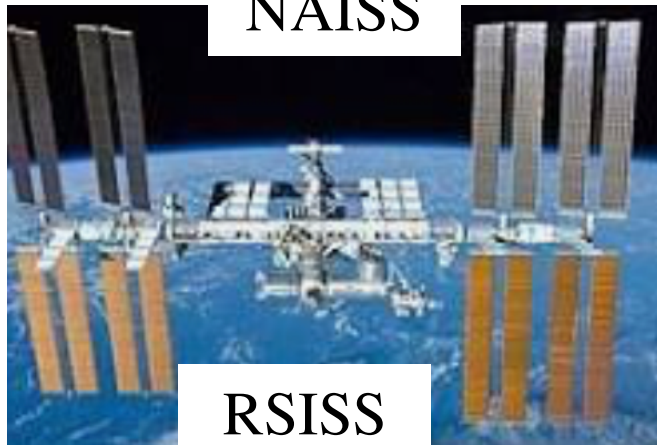
# The Radio Merit Badge

## Requirement: #1 (c & d))

### 1. Explain what radio is. Then discuss the following:

- (c) Radio station call signs and how they are used in broadcast radio and amateur radio
- (d) The phonetic alphabet and how it is used to communicate clearly.

(c.)



Each Ham Radio Operator has a Call Sign of their own. No one else in the World has the same Call Sign.



(d.)

<b>A ALPFA</b>	<b>N NOVEMBER</b>
<b>B BRAVO</b>	<b>O OSCAR</b>
<b>C CHARLIE</b>	<b>P PAPA</b>
<b>D DELTA</b>	<b>Q QUEBEC</b>
<b>E ECHO</b>	<b>R ROMEO</b>
<b>F FOXTROT</b>	<b>S SIERRA</b>
<b>G GOLF</b>	<b>T TANGO</b>
<b>H HOTEL</b>	<b>U UNIFORM</b>
<b>I INDIA</b>	<b>V VICTOR</b>
<b>J JULIETT</b>	<b>W WHISKEY</b>
<b>K KILO</b>	<b>X X-RAY</b>
<b>L LIMA</b>	<b>Y YANKEE</b>
<b>M MIKE</b>	<b>Z ZULU</b>

The Phonetic Alphabet is used in communications to more clearly identify the intended meaning.



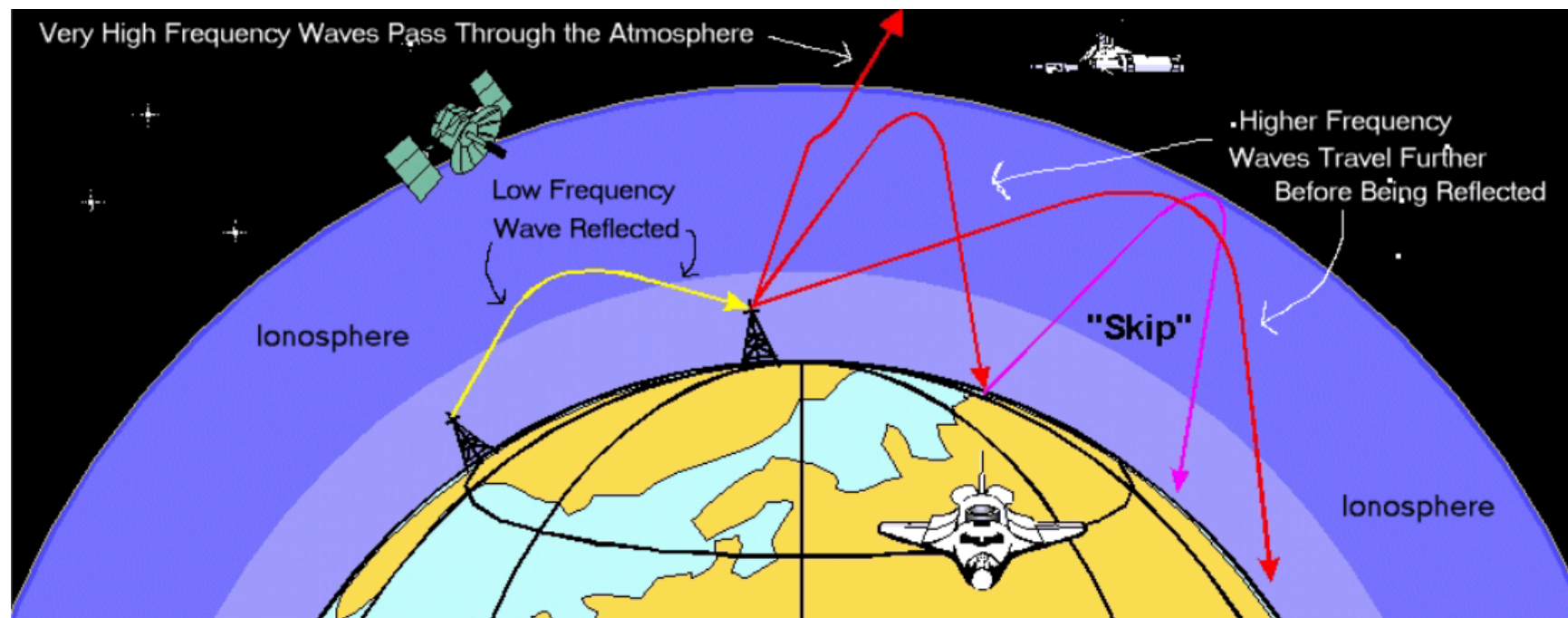
# The Radio Merit Badge

## Requirement: #2 (a & b)

### 2. Do the following:

- (a) Sketch a diagram showing how radio waves travel locally and around the world.
- (b) Explain how the radio stations WWV and WWVH can be used to help determine what you can expect to hear when you listen to a shortwave radio.

a.



b. Since November 15, 2021, WWV and WWVH has been broadcasting a test signal on minute 8 of each hour on WWV, and minute 48 on WWVH. This signal has been created **to assist in ionospheric research**, and is a joint effort of the Ham Radio Citizen Science Investigation (HamSCI)





# The Radio Merit Badge

## Requirement: #2 (c & d)

- (c) Explain the difference between a distant (DX) and a local station.
- (d) Discuss what the Federal Communications Commission (FCC) does and how it is different from the International Telecommunication Union.

**c.** The term **DX** is an old telegraphic term meaning "**long distance.**"

*“Calling CQ DX de WA5YUL”*

Yul is looking to contact a ham radio station OUTSIDE of the USA & Canada.

**d.** The Federal Communications Commission (FCC) is an independent Federal regulatory agency responsible directly to Congress is charged with **regulating interstate and international communications** by radio, television, wire, satellite, and cable. The ITU is an international organization of Amateur Radio associations that work to resolve issues related to ham radio.

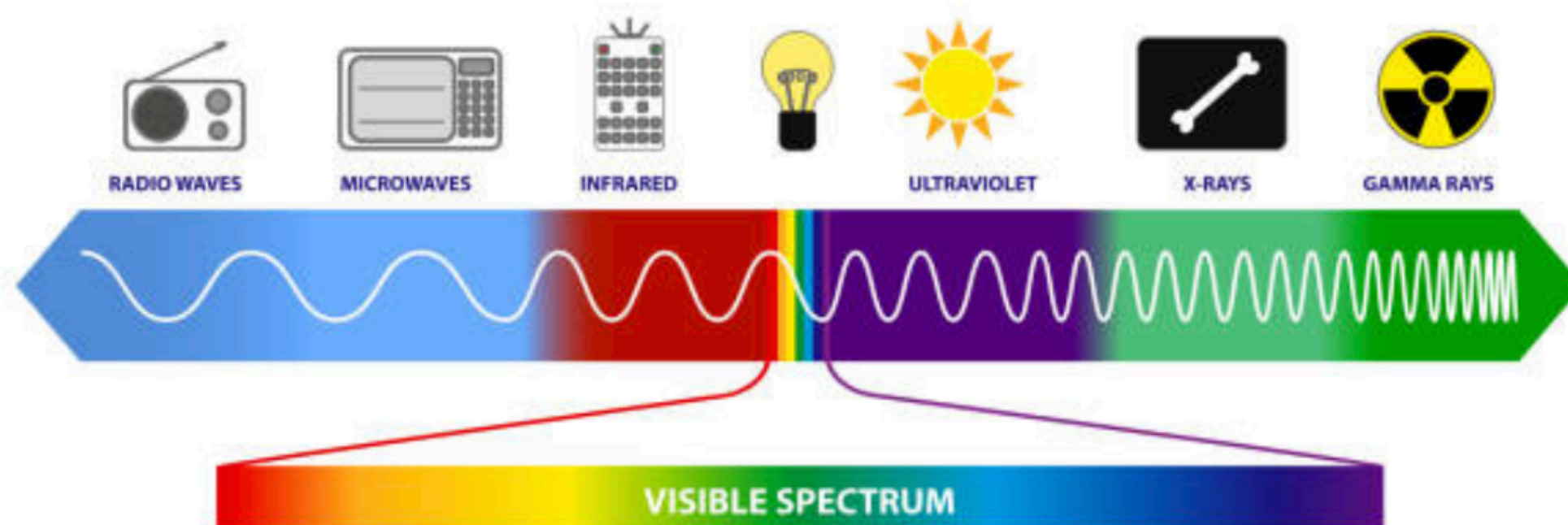


# The Radio Merit Badge

## Requirement: #3

**Do the following:**

- (a) Draw a chart of the electromagnetic spectrum covering 300 kilohertz (kHz) to 3,000 Megahertz (MHz).
- (b) Label the MF, HF, VHF, UHF, and microwave portions of the spectrum on your diagram.
- (c) Locate on your chart at least eight radio services, such as AM and FM commercial broadcast, citizens band (CB), television, amateur radio (at least four amateur radio bands), and public service (police and fire).





# US Amateur Radio Bands

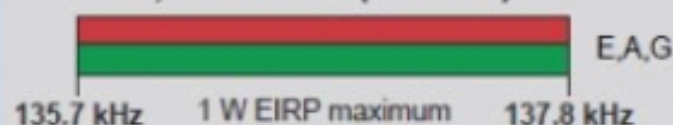
**US AMATEUR POWER LIMITS — FCC 97.313** An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.



**ARRL** The national association for AMATEUR RADIO®

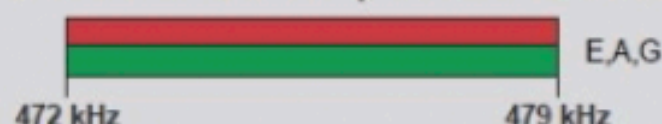
Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at <https://utc.org/plc-database-amateur-notification-process/>. You need only register once for each band.

## 2,200 Meters (135 kHz)



## 630 Meters (472 kHz)

5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.

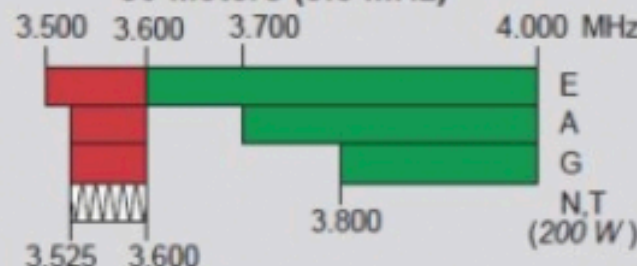


## 160 Meters (1.8 MHz)

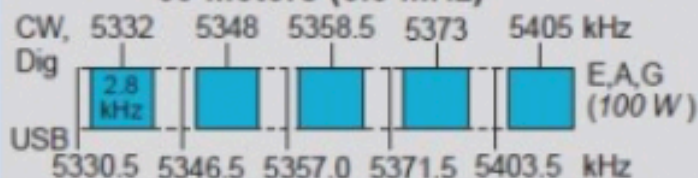
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz



## 80 Meters (3.5 MHz)

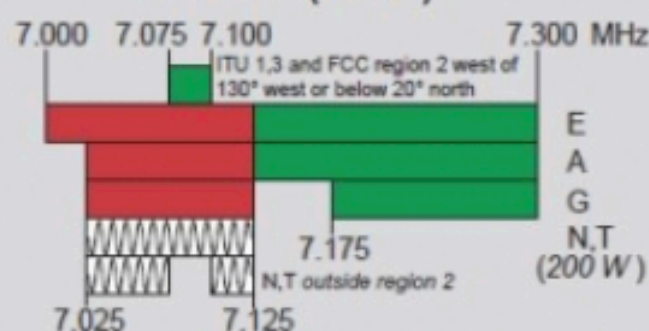


## 60 Meters (5.3 MHz)



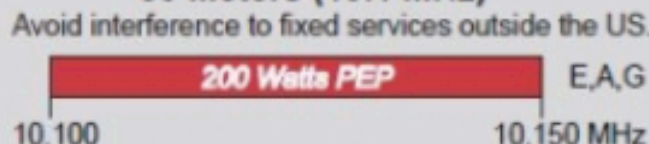
General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.

## 40 Meters (7 MHz)

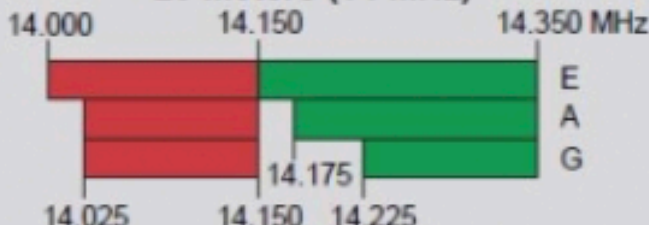


See Sections 97.305(c), 97.307(f)(11) and 97.301(e). These exemptions do not apply to stations in the continental US.

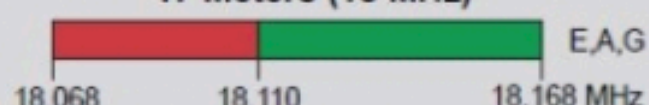
## 30 Meters (10.1 MHz)



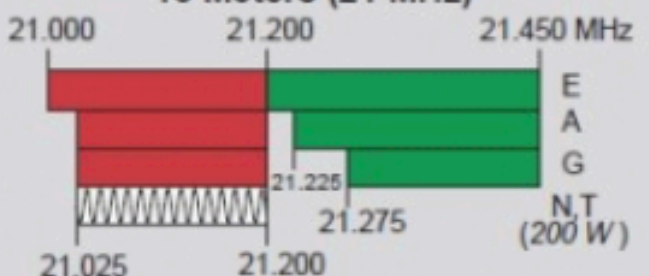
## 20 Meters (14 MHz)



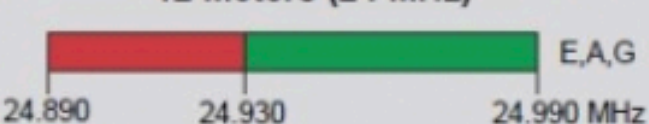
## 17 Meters (18 MHz)



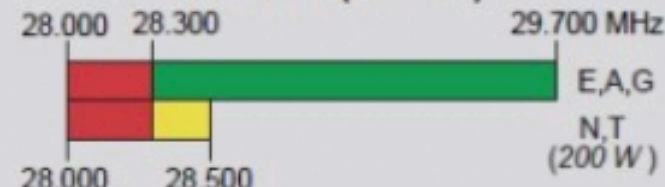
## 15 Meters (21 MHz)



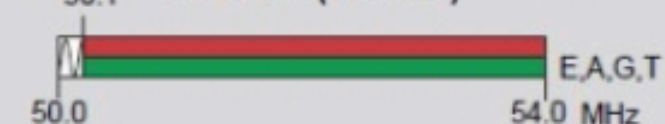
## 12 Meters (24 MHz)



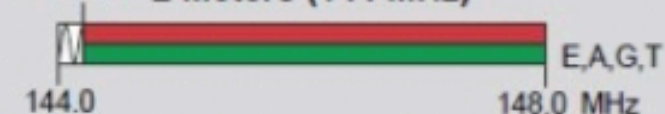
## 10 Meters (28 MHz)



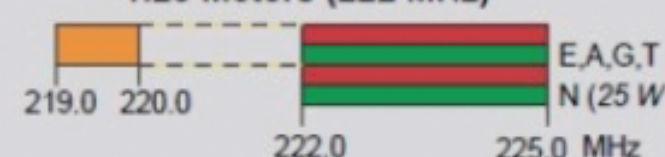
## 6 Meters (50 MHz)



## 2 Meters (144 MHz)

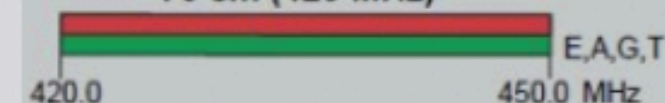


## 1.25 Meters (222 MHz)



\*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

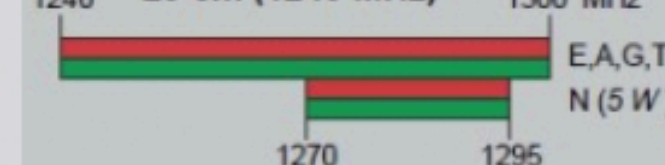
## 70 cm (420 MHz)\*



## 33 cm (902 MHz)\*



## 23 cm (1240 MHz)\*



All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz ‡	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
3300-3500 MHz	47.0-47.2 GHz	241-250 GHz
5650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

‡ No pulse emissions

### KEY

#### Note:

CW operation is permitted throughout all amateur bands.

MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.

Test transmissions are authorized above 51 MHz, except for 219-220 MHz.

- = RTTY and data
- = phone and image
- = CW only
- = SSB phone
- = USB phone, CW, RTTY, and data
- = Fixed digital message forwarding systems only

E = Amateur Extra  
A = Advanced  
G = General  
T = Technician  
N = Novice

See *ARRLWeb* at [www.arrl.org](http://www.arrl.org) for detailed band plans.

## ARRL We're At Your Service

ARRL Headquarters:  
860-594-0200 (Fax 860-594-0259)  
email: [hq@arrl.org](mailto:hq@arrl.org)

Publication Orders:  
[www.arrl.org/shop](http://www.arrl.org/shop)  
Toll-Free 1-888-277-5289 (860-594-0355)  
email: [orders@arrl.org](mailto:orders@arrl.org)

Membership/Circulation Desk:  
[www.arrl.org/membership](http://www.arrl.org/membership)  
Toll-Free 1-888-277-5289 (860-594-0338)  
email: [membership@arrl.org](mailto:membership@arrl.org)

Getting Started in Amateur Radio:  
Toll-Free 1-800-326-3942 (860-594-0355)  
email: [newham@arrl.org](mailto:newham@arrl.org)

Exams: 860-594-0300 email: [vec@arrl.org](mailto:vec@arrl.org)

1,009 × 768

Copyright © ARRL 2017 rev. 9/22/2017

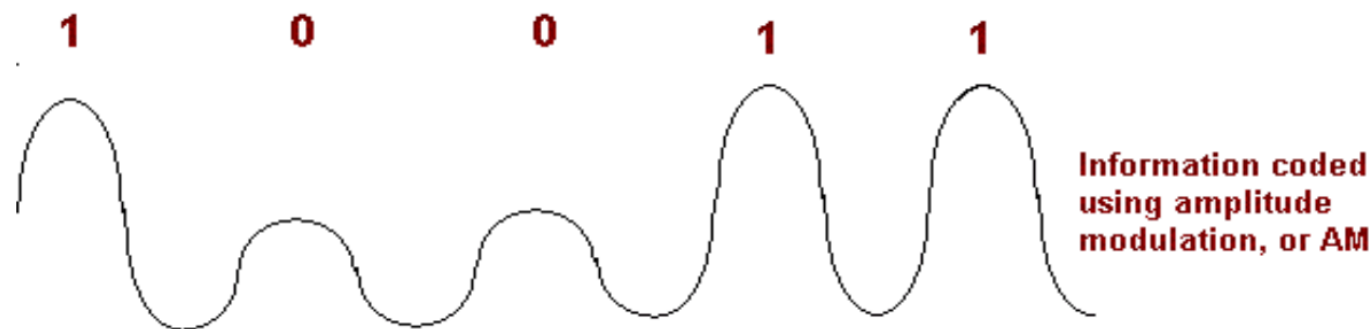




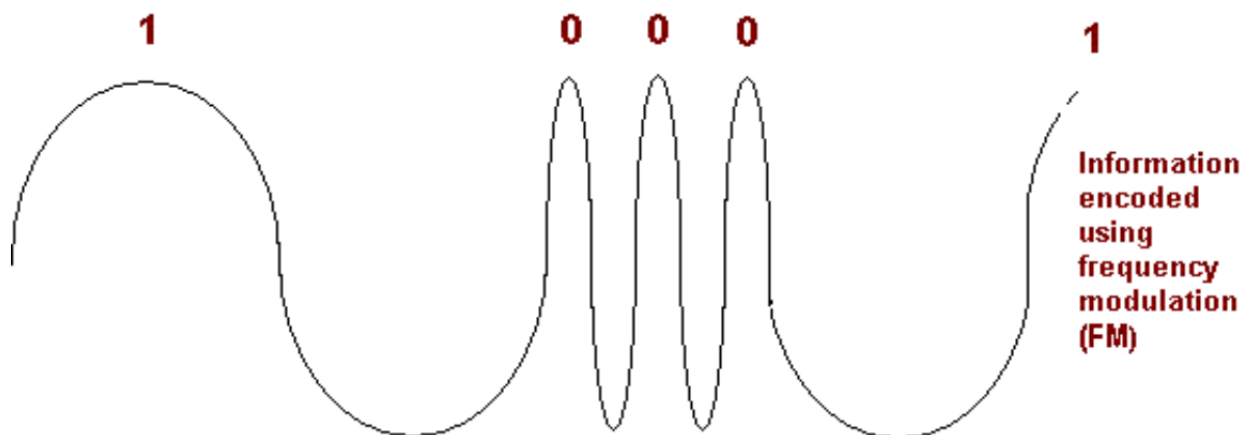
# The Radio Merit Badge

## Requirement: #4

Explain how radio waves carry information. Include in your explanation: transceiver, transmitter, receiver, amplifier, and antenna.



A.M. stands for amplitude modulation. In this method, the information is put into a radio wave by varying the amplitude.



F.M. stands for frequency modulation. This time the amplitude is kept constant, it is the frequency that is varied..





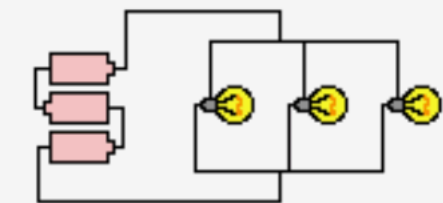
# The Radio Merit Badge

## Requirement: #5 (a & b)

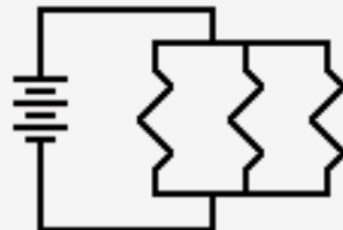
Do the following:

- (a) Explain the differences between a **block diagram** and a **schematic diagram**.
- (b) Draw a block diagram for a radio station that includes a transceiver, amplifier, microphone, antenna, and feed line.

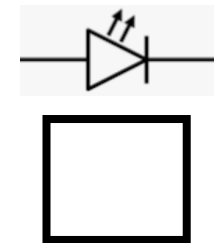
Drawing of a Circuit



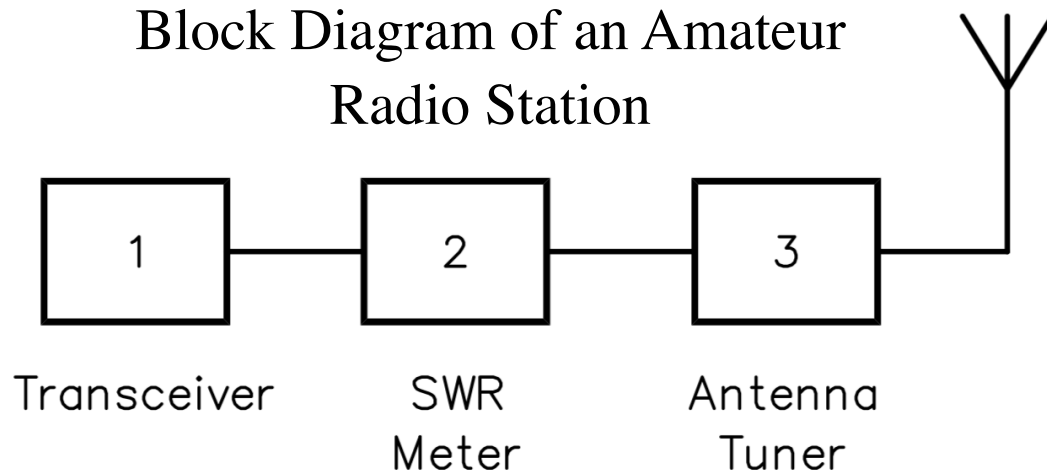
Schematic of a Circuit



Arrange multiple images to create a **Block Diagram** for the Circuit shown.



Block Diagram of an Amateur Radio Station



Where would you put an **amplifier**?

Where would you put a **microphone**?

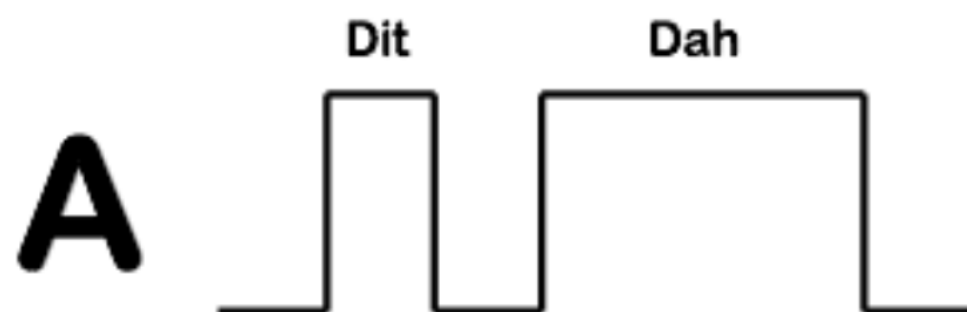


# The Radio Merit Badge

## Requirement: #5

Do the following:

- (c) Discuss how information is sent (CW) **Morse Code transmission**, single sideband (SSB) transmission, and digital transmission.



A	— —	N	— —
B	— — —	O	— — —
C	— — — —	P	— — — —
D	— — —	Q	— — — —
E	—	R	— — —
F	— — — —	S	— — —
G	— — — —	T	— —
H	— — — —	U	— — —
I	— —	V	— — — —
J	— — — — —	W	— — — —
K	— — — —	X	— — — —
L	— — — —	Y	— — — —
M	— —	Z	— — — —
1	— — — — —	6	— — — — —
2	— — — — —	7	— — — — —
3	— — — — —	8	— — — — —
4	— — — — —	9	— — — — —
5	— — — — —	0	— — — — —





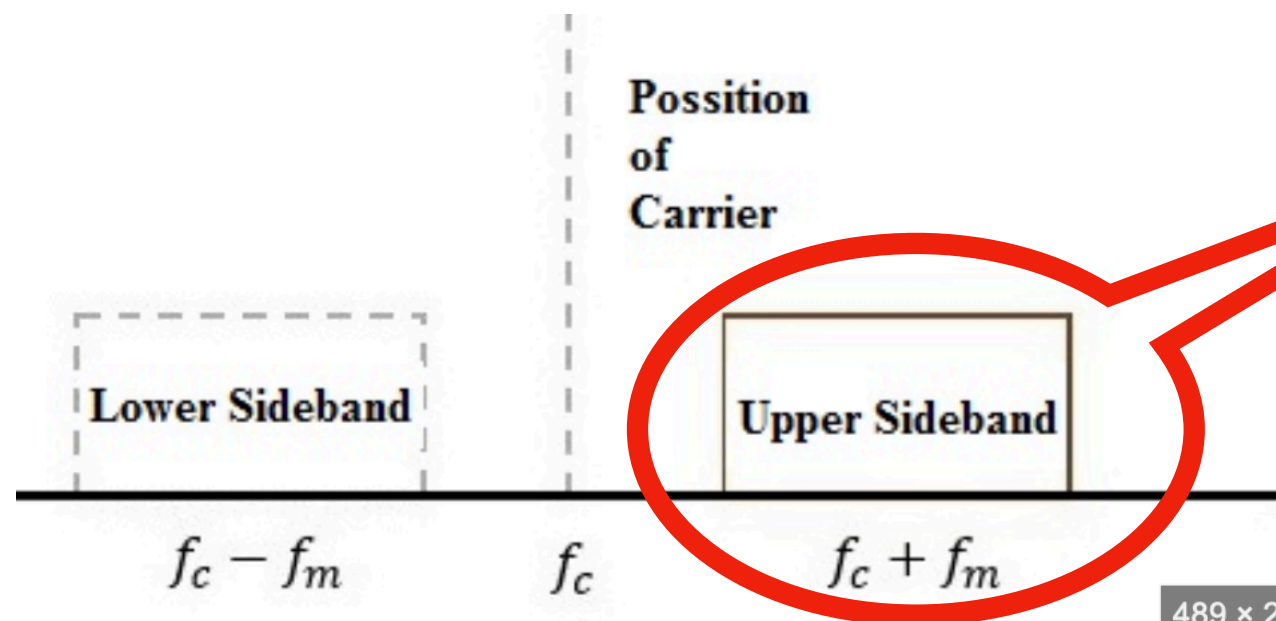
# The Radio Merit Badge

## Requirement: #5

Do the following:

- (c) Discuss how information is sent, using single sideband (SSB) transmission

Single Sideband modulation eliminates the need to transmit the carrier signal, resulting in energy savings.



*Only this part of the signal is sent!*



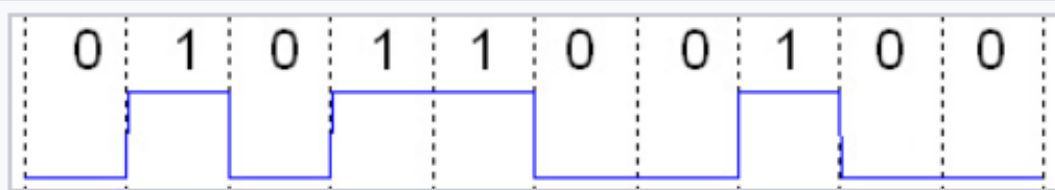
# The Radio Merit Badge

## Requirement: #5

Do the following:

- (c) Discuss **how information is sent during digital transmissions**

Digital signals are a type of data transmission that convert information into **binary code, a series of 1s and 0s**. This binary code is then transmitted as an electromagnetic wave over various media such as wires, fibre optic cables, or wireless signals.



A binary signal, also known as a logic signal, is a digital signal with two distinguishable levels

### Advantages of Digital Transmissions

1. Fewer errors than analog transmissions
2. Higher transmission rates
3. More secure
4. Integrating voice, data and video on the same circuit is far simpler. (digital data are easier to combine)





# The Radio Merit Badge

## Requirement: #5

- (d) Explain how **NOAA Weather Radio** (NWR) can alert you to danger.

**(d) NOAA Weather Radio** is a nationwide network of radio stations broadcasting continuous weather information. NWR broadcasts official Weather Service warnings, watches, forecasts and other hazard information 24 hours a day, 7 days a week.



**Ham Radio's SKYWARN®** (1970) is a volunteer program with between 350,000 and 400,000 trained severe weather spotters. These volunteers help keep their local communities safe by providing timely and accurate reports of severe weather to the **National Weather Service**.

**SKYWARN®** spotters, coupled with Doppler radar technology, improved satellite and other data, has enabled NWS to issue more timely and accurate warnings for tornadoes, severe thunderstorms and flash floods. SKYWARN® storm spotters form the nation's first line of defense against severe weather.





# The Radio Merit Badge

## Requirement: #5

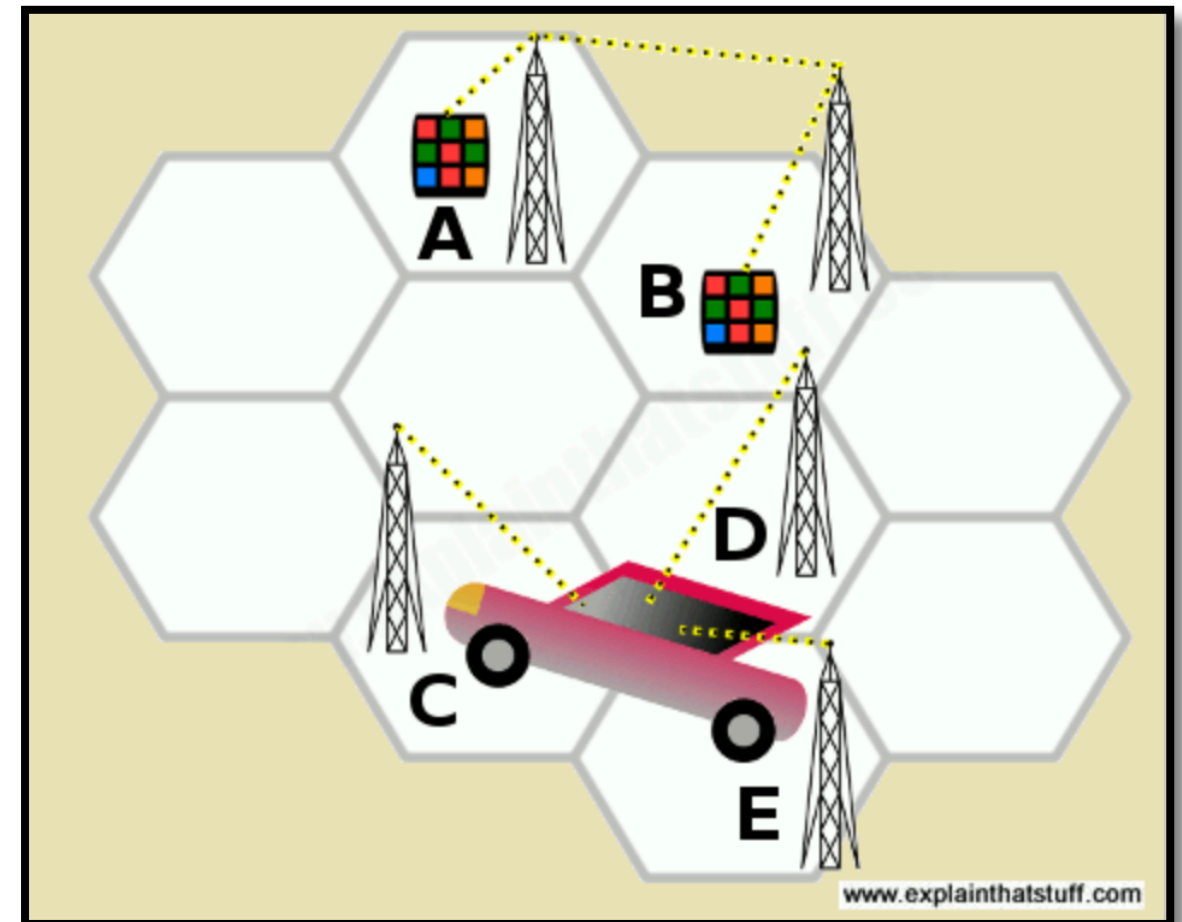
- (e) Explain how **cellular telephones** work. Identify their benefits and limitations in an emergency.

If a phone in cell A calls a phone in cell B, the call doesn't pass directly between the phones, but from the first phone to mast A and its base station, then to mast B and its base station, and then to the second phone.

- Identify their **benefits** and **limitations** in an emergency.

**Benefits:**

**Limitations:**







# The Radio Merit Badge

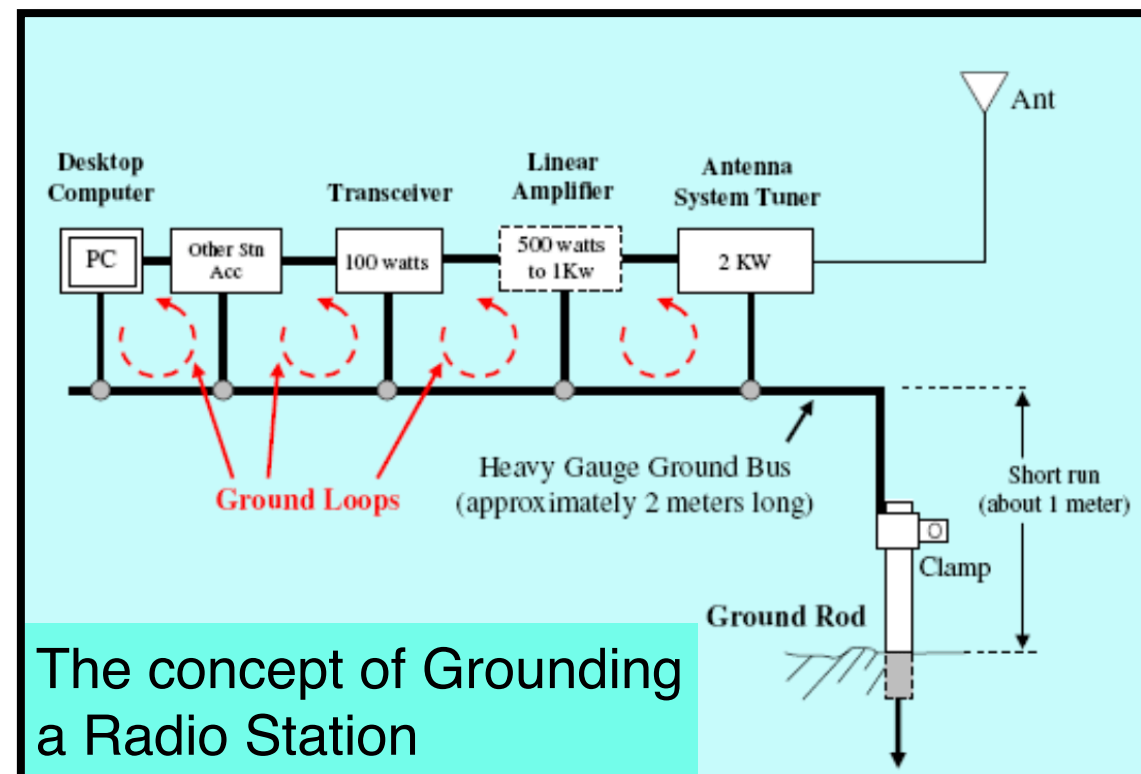
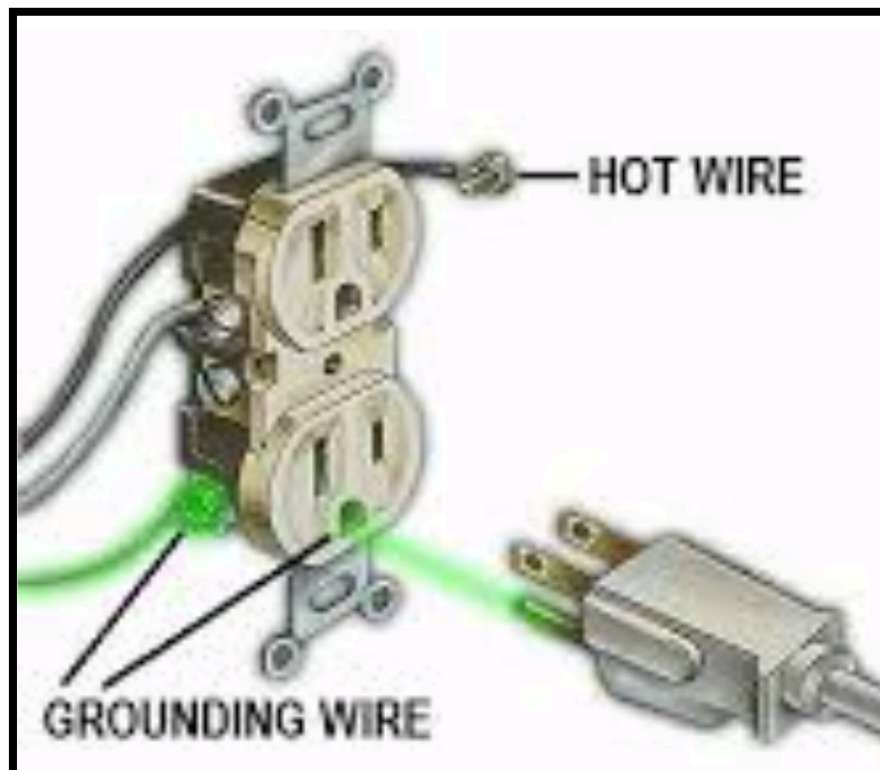
## Requirement: #6

Explain the **safety precautions** for working with radio gear, including the concept of grounding for direct current circuits, power outlets, and antenna systems.

### Radio Frequency (RF) Energy Exposure

The unit "volts per meter" (V/m) is used to express the strength of the electric field (electric "field strength"), and the unit "amperes per meter" (A/m) is used to express the strength of the magnetic field

Biological effects that result from heating of tissue by RF energy are often referred to as "thermal" effects.

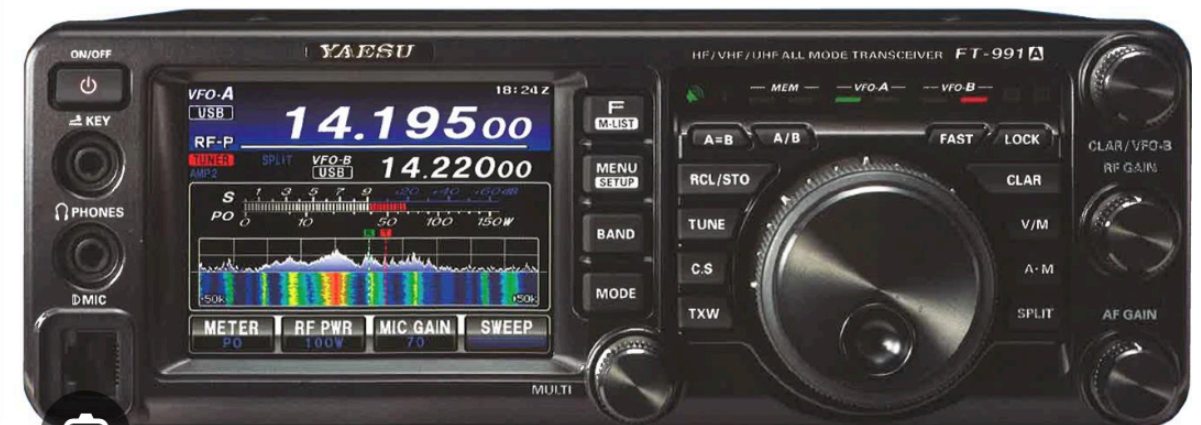




# The Radio Merit Badge

## Requirement: #7

Visit **an amateur radio station**. Discuss what types of equipment you saw in use, how it was used, what types of licenses are required to operate and maintain the equipment, and the purpose of the station.







# The Radio Merit Badge

## Requirement: #8

8. Find out about three career opportunities in radio. *Pick one* and find out the **education, training, & experience required** for this profession.

Discuss this with the Scouts in the audience and explain why a radio related profession might interest them.

*Gerry & Yul:*

*I think the best way for us to address this requirement is to:*

- 1. Explain **briefly** how we got into ham radio and how it tied in with our professional lives.*
- 2. Draw out from the Scouts other professions that they might be interested in pursuing and explore how Ham Radio could help.*



# The Radio Merit Badge

## Requirements: #9 (A) Amateur Radio

- (1) Tell why the FCC has an amateur radio service. Describe activities that amateur radio operators can do on the air, once they have earned an amateur radio license.
- (2) Explain differences between the Technician, General, and Extra Class license requirements and privileges. Explain who administers amateur radio exams.
- (3) Explain at least five Q signals or amateur radio terms.
- (4) Explain how you would make an emergency call on voice or Morse code.
- (5) Explain the differences between handheld transceivers and home “base” transceivers. Explain the uses of mobile amateur radio transceivers and amateur radio repeaters.
- (6) Using proper call signs, Q signals, and abbreviations, carry on a 10-minute real or simulated amateur radio contact using voice, Morse code, or digital mode. (Licensed amateur radio operators may substitute five QSL cards as evidence of contacts with five amateur radio operators.) Properly log the real or simulated ham radio contact, and record the signal report.



# Requirements: #9 (A) Amateur Radio

- (1) Tell why the FCC has an amateur radio service.

The amateur and amateur-satellite services are for qualified persons of any age who are interested in radio technique solely with a personal aim and without pecuniary interest. These services present an opportunity for:

*Education: self-training, intercommunication, and technical investigations.*

*Provide communication in times of emergency & Public Service*

- Describe activities that amateur radio operators can do on the air, once they have earned an amateur radio license.

Send & Receive Digital Messages World-Wide.  
Especially Useful  
During Emergencies.  
NO Internet

Operate portable and participate in  
“Summits on the Air”  
and “Parks on the Air” Activities.

Communicate Using  
Voice, Morse Code,  
Teletype, Feld Hell,  
World-Wide

Receive Slow Scan TV  
Images Transmitted from  
the International Space  
Station



# Requirements: #9 (A) Amateur Radio

- (2) Explain differences between the Technician, General, and Extra Class license requirements and privileges. Explain who administers amateur radio exams.

**Technician Class** license is an entry level into Amateur Radio. It offers and operating privileges in different segments of the radio. spectrum.

**General Class** license provides an upgrade in frequency and operating opportunities

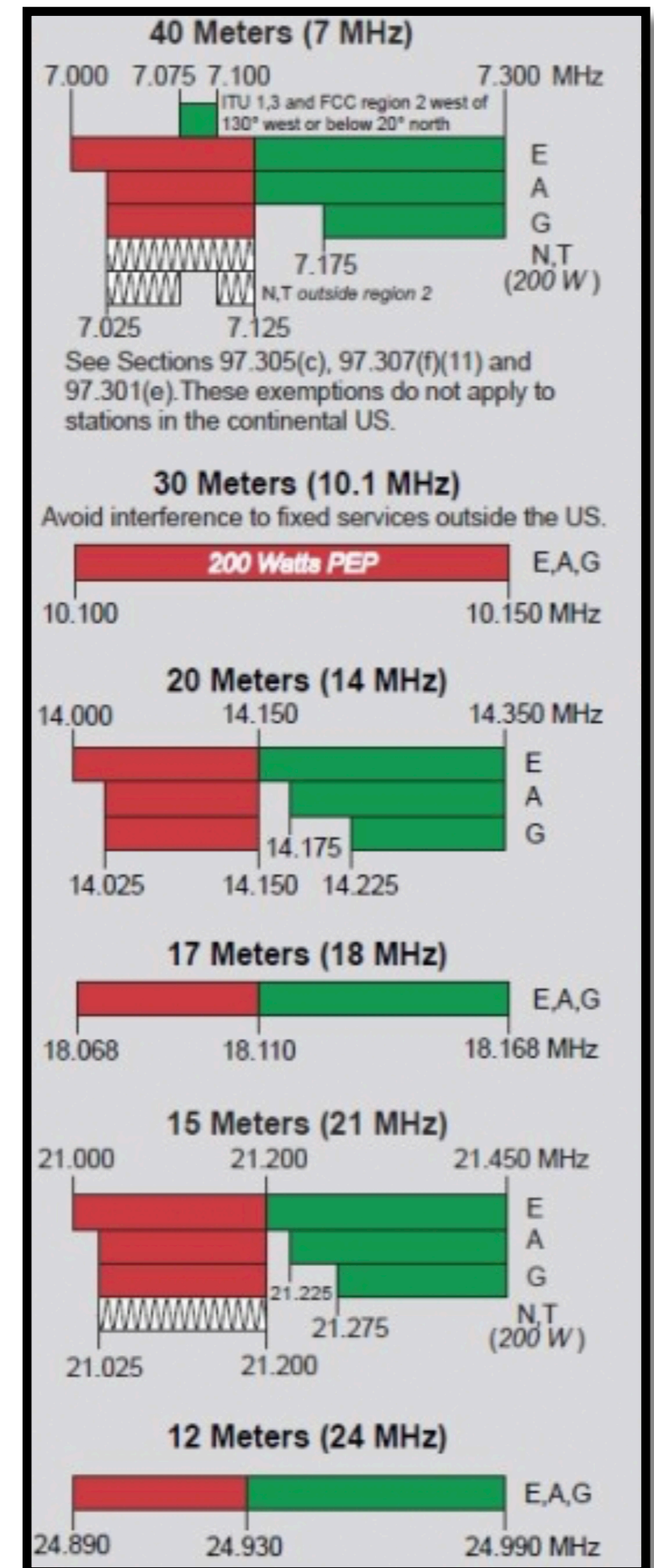
**Extra Class** license provides ALL frequency, mode, power and operating privileges.

A partial list of operating modes and frequencies is clearly identified graphically on the chart.

*All category of Amateur Radio Tests are administered locally by VEs, local Volunteer Examiners Certified to do so!*

*Visit the High Desert Amateur Radio Club's web site for details.*

*<https://www.nm5hd.org>*





# Requirements: #9 (A) Amateur Radio

(3) Explain at least five Q signals or amateur radio terms.

**Q-signals** are a system of radio shorthand as old as wireless.

**Q-signals** are a set of abbreviations for common information that save time and allow communication between operators who don't speak a common language.

---

**QRS** = Send more slowly. Commonly used during morse code training nets. It is really the spacing between the letters that is spread out. The speed the letters are sent remains the same.

**QRT** = Sent to indicate to others that you are about to close your station.

**QTH** = My station is located at: name of the city. State

**QSB** = Your signal is fading. OR Are my signals fading?

**QSL** = Sent to indicate to the other station that you are acknowledging receipt of the contact.

---

**73** = Sent with voice, digital or Morse Code transmissions at the end of a contact.  
“Best Regards”.....

**CQ** = Sent with voice, digital or Morse Code at the beginning of a transmission asking to contact any other station.

# Requirements: #9 (A) Amateur Radio

(4) Explain how you would make an emergency call on voice or Morse code.

**In an emergency, dial 911 from your phone immediately.**

An emergency is any situation that requires immediate assistance from the police, fire department or ambulance.

When you call 911, be prepared to answer the call-taker's questions, which may include: The location of the emergency, including the street address.

## Ham Radio National Calling Frequency: 146.520 MHz

- Turn up your radio's output power to maximum.
- Begin your transmission by saying **“Priority” or “Emergency”** followed by your **call sign**.

A strong signal can get the attention of listening stations. Don't shy away from interrupting an ongoing conversation.

- After you have control of the repeater or the frequency is clear, state that you have an emergency to report.
- Use the **NM Mega Link Map** to select frequencies most likely to reach help.

**Voice:** “Break Break Emergency Emergency”. OR

“Mayday Mayday” this is: State Your Call Sign”. OR

“ Priority Priority, this is: State Your Call Sign”

**Morse Code:** An S O S sent by morse code is a well-known distress signal.

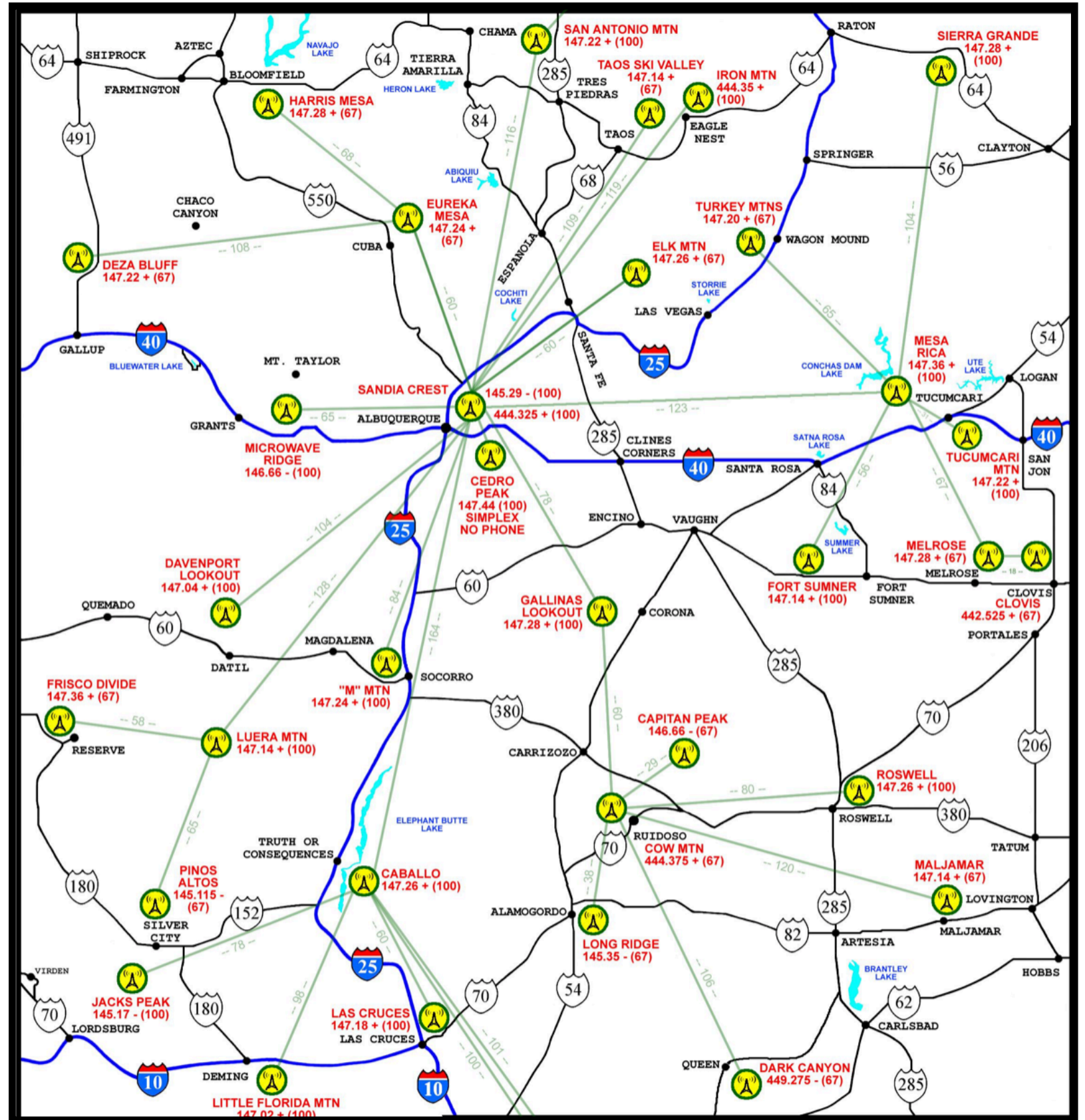
*It is three short taps followed by three long taps, and then three short taps again.*



# The NM Mega-Link

The **Mega-Link** repeater network of more than 30 repeaters cover a major portion of the State of **New Mexico** as well as portions of six surrounding states.

Consider seriously programming your VHF & UHF Radios to the Mega-Link Frequencies in order to reach out for help in areas without cell phone service.



# Find Out About their Situation

Lost - Sick - Injured - Stuck

- **Lost** - *Where was the last place you knew where you were?*
  - *Know Roads, Landmarks, Distances*
- **Sick:** Signs & Symptoms,
  - How Long? Pain & How severe (1-10), Medical Hx?, Meds?, Dr.?
- **Injured:** Mechanics of Injury. How did you get hurt?
  - Level of Consciousness? x3, for how long?
  - Nature of Injury - Type of Wound, Severity, Bleeding (location)
- **Stuck:** Vehicle Type, Color, Description of Conditions, Vehicle Damage, Drivable
  - Is the vehicle currently stable or at risk?
  - What do you think has to be done to get you out?



**Are You Prepared:** Shelter?  
Water? Food? Heater? Fuel in  
vehicle? Sleeping Bag? Warm  
Dry Clothing, Extras?



# Requirements: #9 (A) Amateur Radio

- (5)a. Explain the differences between handheld transceivers and home “base” transceivers.  
Explain the uses of mobile amateur radio transceivers and amateur radio repeaters.

## Hand-Held VHF/UHF



Low Power  
FM Only  
Local Contacts  
Uses Repeaters  
Low Cost, < \$50

## Mobile HF & 6 Meters



Power: 100 Watts  
Modes: CW, Voice, FM  
Digital Modes w/Sound Card  
Requires 12 Volts  
Excellent for Portable Outdoor  
Operations & EmComm

## Base Station



Superior Quality of Design & Construction  
Additional Features  
Very Expensive \$3,600  
Dual receivers  
Color Scope Display  
Large Antennas mounted outside the home  
increase the station's ability to communicate.

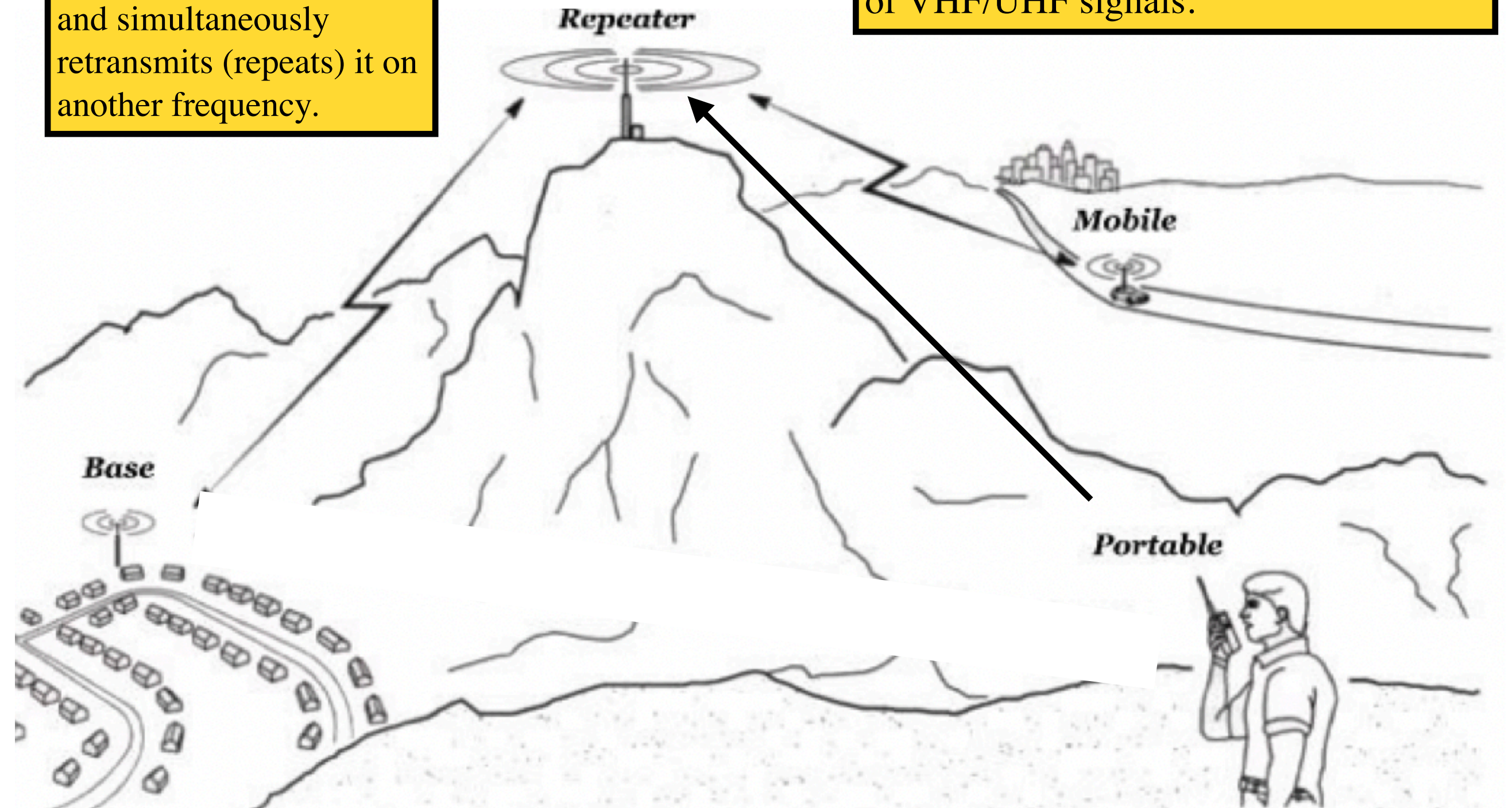


# Requirements: #9 (A) Amateur Radio

(5)b. Explain the uses of mobile amateur radio transceivers and amateur radio repeaters.

A repeater receives a signal on one frequency and simultaneously retransmits (repeats) it on another frequency.

Repeaters can greatly increase the range of VHF/UHF signals.





# Requirements: #9 (A) Amateur Radio

- (6) Using proper call signs, Q signals, and abbreviations, carry on a 10-minute real or simulated amateur radio contact using voice, Morse code, **or digital mode**. (*Licensed amateur radio operators may substitute five QSL cards as evidence of contacts with five amateur radio operators.*)  
*Properly log the real or simulated ham radio contact, and record the signal report.*

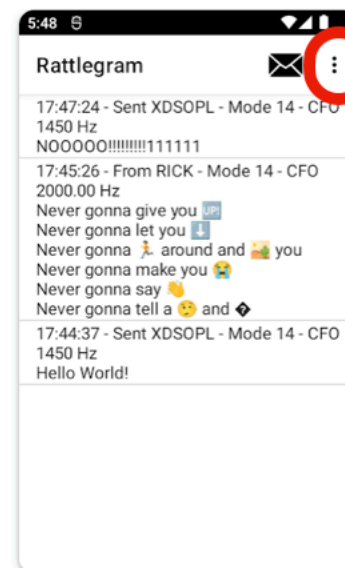
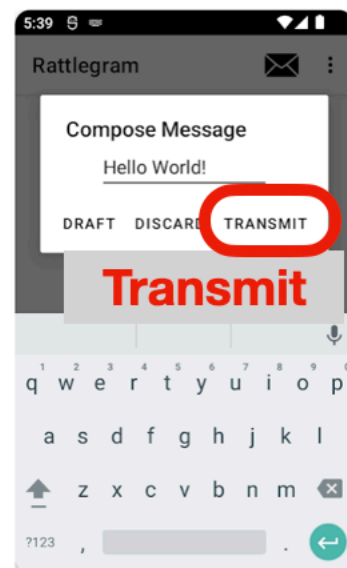
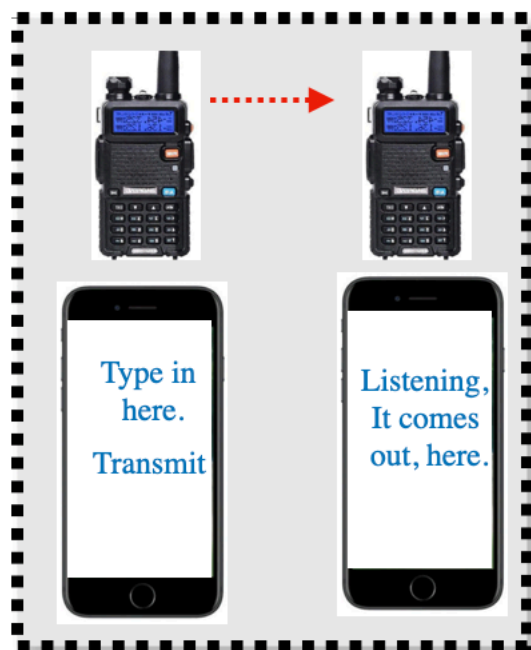
## *Use Rattlegram for a Digital Text Messaging Contact.*

**Rattlegram** uses your cell phone simply as a *terminal* for sending & receiving text messages using the audio tones it generates.



1. Download & Install **Rattlegram** from Google: **Rattlegram for Android.**
2. Open **Rattlegram**. (Adjust Audio Levels, IF need be) →
3. Allow Access to the Cell Phone's Microphone (*see Menu*)
4. Type in a short Message, or just a Ping (*Bell Icon*)
5. Use data frequencies over VHF, UHF, HF & (FRS, & GMRS)
6. Click on **Transmit**. Leave Open to **Receive**.

V  
O  
L  
U  
M  
E  
B  
A  
R



### Menu

**Audio Source - Microphone**  
**Danger Zone - Delete Messages**  
- Force Quit  
**Parrot Mode - Sends message back**

**Your Text Messages are NOT Private!!**

# Requirements: #9 (A) Amateur Radio

(6) Using proper call signs, Q signals, and abbreviations, carry on a 10-minute real or simulated amateur radio contact using voice, Morse code, **or digital mode**. (Licensed amateur radio operators may substitute five QSL cards as evidence of contacts with five amateur radio operators.) *Properly log the real or simulated ham radio contact, and record the signal report.*

***Use Baofeng Hts for a Voice Contact (QSO).***

*Work with an assigned Ham radio operator for this activity.*

Announce that you are on the air. “K5ABC, Kilo Five Alpha Bravo Charlie, *Listening*”

Kilo Five Alpha, Bravo Charlie..... Whiskey Five XRay, Yankee, Zulu, *Over*

W5XYZ, good morning! You have a strong signal, reading you five by nine. Name is Tony, *Over*.

Hello Tony, how nice to meet you. Name is Fred, and am operating from my home in Lincoln, Nebraska. My rig is a Icom 7300 running 100 watts into a vertical antenna. *Over*.

*Since you identified your call sign at the beginning of the contact and have to do it every 10 minutes and at the end of the QSO (contact) you can go back and forth about the weather, ham radio activity in your area, interesting contacts you have had with other hams, and band conditions. Almost anything is fair game. Content about religion or politics is generally considered poor operating etiquette.*

**End the Contact:** 73 Fred, this is Kilo Five Alpha Bravo Charlie, OUT!