1. What is Communication?
    a. Communication is the process of transferring information from a sender to a receiver with the use of a medium, in which the communicated information is understood by both. This is usually accomplished via a common system of symbols.
2. What are communication and information systems?
    a. Systems designed to collect, process, or exchange information.
3. What is a radio link?
    a. Radio equipment for communication between two stations and the path the signal follows through the air.
4. What are the 7 components of a radio link?
    a. Transmitter
    b. Power Supply
    c. Transmission Lines
    d. Transmitting Antenna
    e. Propogation path
    f. Receiving antenna
    g. Receiver
5. What is the purpose of the transmitter?
    a. Generates a radio signal.
6. What is the purpose of the Power Supply?
    a. Supplies power for operating voltage to of radio.
7. What is the purpose of the Transmission Line?
    a. Delivers signal from transmitter to antenna.
8. What is the purpose of the Transmitting antenna?
    a. Sends radio signal into space toward receiving antenna.
9. What is the propagation path?
    a. Path the radio signals follow as it goes to the receiving antenna.
10. What is the purpose of the receiving antenna?
    a. Intercepts or receives signal and send it through a transmission line to the receiver.
11. What is the purpose of the receiver?
    a. Processes radio signal so the human ear can hear it.
12. What is the goal of the operator while transmitting?
    a. Provide the strongest possible signal at the site of the receiving station.
13. What is propagation velocity?
    a. Travel at the speed of light which is roughly 300,000,000 m/s
    b. Travel near the surface of the earth
    c. Radiate skyward at various angles to Earth's surface
14. What is wavelength?
    a. Distance between crests of a wave
    b. Length is measured in meters
15. What are some common means of communication?
    a. Visual

    b. Sound
    c. Messenger
    d. Wire
    e. Radio

16. What are basic rules for radio communications?
    a. Before operation, ensure equipment is properly configured.
    b. Use established formats to transmit information.
    c. Use phonetic alphabet and numbers, as communication clarity varies widely.
    d. Transmit clear, complete, and concise messages.
    e. Listen before transmitting to avoid interfering with other transmissions.
    f. Minimize transmission time.
17. What should never be done while speaking on a radio?
    a. Violate radio silence.
    b. Disclose sensitive information without authorization
    c. Make needlessly long transmissions.
    d. Engage in unofficial conversation.
    e. Identify individuals or personal information.
    f. Show loss of temper or use profane language.
18. What are procedure words?
    a. Procedure words are used to help radio operators and minimize transmission time.
19. What are common prowords?
    a. Common prowords are words commonly used while conducting radio opeations.
    b. They are not interchangeable, meaning every word has a specific meaning. an example of this is "say again" vs "repeat".
20. What are common strength pro-words?
    a. loud-your signal is very strong
    b. good-signal strength is good
    c. weak-signal strength is weak
    d. very weak-continuous reception is not reliable
    e. clear-quality os transmission is excellent
21. What are common readability pro words?
    a. readable-transmission is satisfactory
    b. unreadable-cannot understand you
    c. distorted-signal is distorted
    d. interference-signal experiencing interference
22. How are numerals transmitted during radio communications?
    a. Numerals will be transmitted digit by digit except multiples of thousands may be spoken as such. However, there are special cases, such as in anti-air warfare reporting procedures in which normal pronunciation of numerals is prescribed and this rule does not apply. For example, 17 would then be SEVENTEEN.
23. What are ways to improve transmission security?
    a. • Radio checks will not be made unless absolutely necessary.
    b. • Excessive radio checks are a violation of transmission security.

c. • A station is understood to have good signal strength and readability unless otherwise notified.
d. • Pro words will be used to conduct radio checks

24. Two types of communication that reconnaissance Soldiers must be subject matter experts in:
    a. Line of sight communications (LOS)
    b. Beyond line of sight communications (BLOS)
25. What is line of sight communication?
    a. Line of sight communication refers to how radio waves travel from the transmit antenna to the receive antenna, limited by the visible horizon, due to the curvature of the earth.
26. Due to the curvature of the earth an antenna that is 6 feet (2 meters) tall will transmit
    a. 5.0km
27. LOS AN
    a. fDistance in km = square root of (12.7 x Am)
    b. (Am = the height of the antenna in meters)
28. Radio communication range is greatly influenced by three factors. What are they?
    a. 1) Frequency of operation
    b. 2) Radio output power
    c. 3) Antenna height
29. Any radio that transmits is a LOS radio. Due to infrastructure or radio band properties, some radios can provide Beyond LOS capabilities. What are these?
    a. - Infrastructure: Relays, retransmission sites, satellites.
    b. - Radio Band properties: High frequency sky wave propagation.
30. What is beyond line of sight communications?
    a. Communication that extends past the visible horizon. And can include the possibility of communicating around the world with a single transmission.
31. Two types of beyond line of sight communications that are commonly used are?
    a. Satellite (SATCOM/TACSAT)
    b. High Frequency (HF)
32. Why is tactical satellite (TACSAT) radio a reliable beyond line of sight communication system?
    a. TACSAT relies on satellites to relay communications to over 90% of the earth's surface.
33. What are the characteristics of the AN/PRC-117F?
    a. Frequency Range: 30 - 512 MHz
    b. Power Output: 10 (VHF) 20 (UHF) watts
    c. Planning Range: 7 - 10 km (LOS)
    d. Modes of Operation: Normal, Integrated Waveform (IW), Clone, Remote, Beacon, High Performance Waveform (HPW), DAMA, Scan, Test
    e. Weight: 9.9lbs w/o batteries
34. What are the characteristics of the Advanced SINCGARS Improvement Program (ASIP)?
    a. Frequency Range: 30 - 87.975 MHz

b. Power Output: 4.0 - 4.4 watts
c. Planning Range: 3 - 5 km
d. Modes of Operation: Single Channel, Frequency Hop, Frequency Hop Master, Frequency Hop 2, Frequency Hop Master 2
e. Weight: 9 lbs w/ battery, handset and antenna

35. What are the characteristics of the MultiBand Intra/Inter Team Radio?
    a. Frequency Range: 30 - 512 MHz
    b. Power Output: .1, .5, 1, 3 or 5 watts
    c. Planning Range: 3 - 5 km
    d. Modes of Operation: Basic, SINCGAR, ANDVT, Havequick and Havequick II
    e. Weight: 2.2 lbs including
    f. battery and antenna
36. What are the characteristics of the MBITR2?
    a. Frequency Range: 30 - 1,850 MHz
    b. Power Output: 5 watts (LOS)
    c. 10 watts (SATCOM)
    d. Planning Range: 3 - 5 km (LOS)
    e. Modes of Operation: VHF/UHF AM/FM, Havequick I and II,
    f. SINCGARS, SATCOM, Retransmission, P25, SA (Situational Awareness), Beacon, SRW (Soldier Radio Waveform), Embedded GPS
    g. Weight: 2.61 lbs including battery and antenna
37. What are the characteristics of the AN/PRC-152?
    a. Frequency Range: 30 - 512 MHz
    b. Power Output: 5w (LOS) 10w (TACSAT)
    c. Planning Range: 3 - 5 km
    d. Modes of Operation: DAMA, SINCGARS, VHF/UHF AM/FM, Havequick II, HPW-IP, HPW, APCO P25
    e. Weight: 2.4 lbs, including
    f. battery and antenna
38. What are the specifications of the AM/PRC-117G?
    a. Frequency Range: 30 MHz- 2 GHz
    b. Power Output: 10 (VHF) 20 (UHF) watts
    c. Planning Range: 7 - 10 km (LOS)
    d. Modes of Operation: SINCGARS, Havequick II, VHF/UHF AM and FM,
    e. DAMA, 181B Dedicated Channel TACSAT, High Performance Waveform (HPW), and the Harris Advanced Networking Wideband Waveform (ANW2).
    f. Weight:8 lbs w/o batteries
39. How are HF comms used?
    a. Before SATCOM technology existed, HF communication was the only way to communicate beyond the horizon. Today HF is still used for long distance communications. It has the advantage of not requiring (or relying on) any infrastructure, but rather utilizing the Earth's atmosphere.
40. What are the characteristics of the AN/PRC-150?
    a. Frequency Range: 1.6 - 60 MHz

b. Power Output: 10 watts VHF
c. 20 watts HF
d. Planning Range: 7 - 10 km (LOS)
e. Modes of Operation: 3G, ALE, HOP, FIX
f. Weight:9.8 lbs w/o batteries

41. What are the characteristics of the AN/PRC-160?
    a. Frequency Range: 1.5 - 60 MHz
    b. Power Output: 1, 5, 10 watts VHF
    c. 1, 5, 20 watts HF
    d. Planning Range: 7 - 10 km (LOS)
    e. Modes of Operation: Wide Band HF Data, ALE, Frequency Hopping, Encrypted Data, Vocoder
    f. Weight:8.7 lbs w/o batteries
42. Of the four LOS radios discussed; the AN/PRC-119 / 148 / 152, and MBITR2, which ones can achieve beyond LOS capabilities and how?
    a. - AN/PRC-119F: Through ground based relays and retransmission sites.
    b. - AN/PRC-148: TACSAT or ground based relays and retransmission sites.
    c. - MBITR2: TACSAT or ground based relays and retransmission sites.
    d. - AN/PRC-152: TACSAT or ground based relays and retransmission sites.
43. Though the AN/PRC-150 and AN/PRC-117 are larger than hand held radios, what are some of their capabilities?
    a. They push more power, and will provide more LOS range at the expense of convenience to the user.
44. What should you always do before you leave for a reconnaissance mission?
    a. Know the locations (grid) to whom you are reporting to and friendly units in your area of operation (AO).
    b. Conduct a COMMEX with the base station and other units in your AO.
    c. Have enough batteries to conduct your mission plus one additional day.
    d. Know the frequencies and locations of supporting units (MEDEVAC, Link-up, CAS, and Artillery).
    e. Know when COMSEC roll times are and the days they occur.
    f. Have a primary, secondary, and if possible a tertiary form of communication. (Iridium / Thuraya satellite phones)
    g. Understand the Terrain and how it will effect communications when you plan your ORP, HS/SS, etc. (don't be afraid to move the site if comms are not working)
45. What is the life cycle of the different radio batteries?
    a. AN/PRC-150 BB-2590 18-20 HOURS
    b. AN/PRC-148 Non-Lithium 6-8 HOURS
    c. BB-2590 36 HOURS
    d. CF-19 BB-2590 4-6 HOURS
    e. Using the military standard 8:1:1 ratio.
    f. (80% scanning, 10% TX and 10% RX)
46. Why are tactical radios necessary for combat operations?

    a. Tactical radios are a necessity for Soldiers during military operations. Squad leaders and higher use tactical radios to communicate and share a common view of the operational environment. Tactical radios provide Soldiers the ability to send and receive voice, data, and video communication. Tactical radio systems are the primary means for Soldiers to communicate during operations.

47. What are the different types of radios?
    a. High frequency (HF) radios.
    b. Very high frequency (VHF) radios.
    c. Ultrahigh frequency (UHF) radios.
    d. Multiband radios. Multimode radios.
    e. Secure wireless broadband solutions microwave radios.
48. What is the purpose of tactical radio networks?
    a. Tactical radio networks play a vital role in facilitating command and control and providing situational awareness during operations. The primary function of tactical radio networks is voice transmission to enablecommunication and situational awareness at all echelons, across all phases of operations. It assumes asecondary role for data transmission where other data capabilities do not exist. Tactical radio networks arelocated at every echelon in the tactical force.
49. What is a communications network?
    a. Acommunications network is an organization of stations capable of intercommunications, but not necessarilyon the same channel (JP 6-0). A message is any thought or idea expressed briefly in a plain or secret languageand prepared in a form suitable for transmission by any means of communication.
50. What does successful HF performance depend on?
    a. Type of emission. Amount of transmitter power output. Characteristics of the transmitter antenna. To select the best antenna the planner requires an understanding of wavelength, frequency, resonance, and polarization. Amount of propagation path loss. Characteristics of the receiver antenna. Amount of noise received. Sensitivity and selectivity of the receiver. An approved list of available frequencies within a selected frequency range.
51. What characteristics of HF radios make them ideal for long distance, wide area communications?
    a. HF signals reflected off the ionosphere at high angles allow beyond line of sight communicationsat distances up to 400 miles (643.7 kilometers), without gaps in communications coverage. HF signals reflected off the ionosphere at low angles allow communication over distances of manythousands of miles. HF signals do not require using either SATCOM or RETRANS assets. HF systems engineered to operate independently of intervening terrain or man-made obstructions.
52. What is radio frequency?
    a. Number of complete cycles per second
    b. Measured as hertz, but is often measured in kilohertz or megahertz.
    c. Frequencies are divided into groups or bands of frequencies.
    d. Most radio sets operate at frequencies of 2-400 mHZ

53. What is the formula for radio frequency?
    a. Frequency = radio wave speed / wavelength
54. What is the formula for wavelength?
    a. Wavelength = radio wave speed / frequency
55. What are the characteristics of HF frequency?
    a. 0-50 mile ground wave range
    b. 100-8000 mile sky wave range
    c. .5-5 kW power required
56. What are the characteristics of VHF frequency?
    a. 0-30 mile ground wave range
    b. 50-150 miles sky wave range
    c. .5 or less kW power required
57. What are the characteristics of UHF frequency?
    a. 0-50 miles ground wave range
    b. N/A sky wave range
    c. .5 or less kW power required
58. Radio waves travel two paths from a transmitter to a receiver. What are they?
    a. Ground wave- Wave travels directly from transmitter to a receiver
    b. Sky wave- Travels into the ionosphere and is refracted to Earth
59. How do different frequencies travel from transmitter to receiver?
    a. UHF and VHF transmissions are by ground waves
    b. HF transmission is done mostly by sky waves
60. What are the characteristics of Ground Wave Propogation?
    a. Do not use waves that are refracted from the ionosphere.
    b. Affected by the electrical characteristics of the earth and diffraction of waves around the curvature of the earth.
    c. Strength of the ground waves depends on power output, transmitter frequency, shape and conductivity of the earth along the transmission path and local weather.
61. What are the components of a ground wave
    a. Direct Waves
    b. Ground Reflected Wave
    c. Surface Wave
62. What is a direct wave?
    a. The direct wave is that part of the radio wave which travels directly from the transmitting antenna to the receiving antenna. This part of the wave is limited to the line of sight (LOS) distance between the transmitting and receiving antennas, plus the small distance added by atmospheric refraction and diffraction of the wave around the curvature of the Earth. This distance can be extended by increasing the height of the transmitting antenna, the receiving antenna, or both.
63. What is a ground reflected wave?
    a. The ground reflected wave is that portion of the radio wave which reaches the receiving antenna after being reflected from the surface of the earth. Cancellation of the radio signal can occur when the ground reflected component and the direct

wave component arrive at the receiving antenna at the same time and are 180° out of phase with each other.

64. What is a surface wave?
    a. The surface wave, which follows the curvature of the Earth, is that part of the ground wave which is affected by the conductivity and dielectric constant of the Earth.
65. What does sky wave propagation depend on?
    a. Radio communications that use sky wave propagation depend on the ionosphere to provide the signal path between the transmitting and receiving antennas.
66. How many layers does the ionosphere have? What are these layers?
    a. The ionosphere has four layers (see fig. 1-6). In order of increasing heights and decreasing molecular densities, these layers are labeled D, E, F1, and F2. During the day, when the rays of the Sun are directed toward that portion of the atmosphere, all four layers may be present. At night, the F1 and F2 layers seem to merge into a single F layer, and the D and E layers fade out. The actual number of layers, their height above the Earth, and their relative intensity of ionization varies constantly.
67. Describe each layer of the ionosphere?
    a. The following are layers of the ionosphere:
    b. D—exists only during daylight hours and has little effect in bending the paths of high frequency radio waves. The main effect of the D layer is to attenuate high frequency waves when the transmission path is in sunlit regions.
    c. E—used during the day for high frequency radio transmission over intermediate distances (less than 2,400 km [1,500 mi]). At night, the intensity of the E layer decreases, and it becomes useless for radio transmission.
    d. F—exists at heights up to 380 kilometers (240 mi) above the Earth and is ionized all the time. It has two well-defined layers (F1 and F2) during the day, and one layer (i.e., F) during the night. At night, the F layer remains at a height of about 260 kilometers (170 mi) and is useful for long-range radio communications (over 2,400 km [1,500 mi]). The F2 layer is the most useful of all layers for long-range radio communications, even though its degree of ionization varies appreciably from day to day.
68. What contributes to ionospheric variations?
    a. The movements of the Earth around the Sun and changes in the Sun's activity contribute to ionospheric variations. There are two main classes of variations: regular, which is predictable; and irregular, which occurs from abnormal behavior of the Sun.
69. What are regular ionospheric variations?
    a. The regular variations are—
    b. Daily—caused by the rotation of the Earth.
    c. Seasonal—caused by the north and south progression of the Sun.
    d. 27-day—caused by the rotation of the Sun on its axis.
    e. 11-year—caused by the sunspot activity cycle going from maximum to minimum, back to maximum levels of intensity.

70. What must be anticipated when planning a communications system?
    a. The current status of the four regular variations must be anticipated when planning a communications system. There are also unpredictable, irregular variations that must be considered. They have a degrading effect (at times blocking communications) which cannot be controlled or compensated for at present.
71. What are examples of irregular ionospheric variations?
    a. Some irregular variations are—
    b. Sporadic E. When it is excessively ionized, the E layer often blocks out the reflections back from the higher layers. It can also cause unexpected propagation of signals hundreds of miles beyond the normal range. This effect can occur at any time.
    c. Sudden ionospheric disturbance (SID). A sudden ionospheric disturbance coincides with a bright solar eruption and causes abnormal ionization of the D layer. This effect causes total absorption of all frequencies above approximately 1 MHz. It can occur without warning during daylight hours and last from a few minutes to several hours. When SID occurs, receivers seem to go dead.
    d. Ionospheric storms. During these storms, sky wave reception above approximately 1.5 MHz shows low intensity and is subject to a type of rapid blasting and fading called "flutter fading." These storms may last from several hours to days and usually extend over the entire Earth.
72. How do sunspots impact wave propogation?
    a. Sunspots generate bursts of radiation that cause high levels of ionization. The more sunspots, the greater the ionization. During periods of low sunspot activity, frequencies above 20 MHz tend to be unusable because the E and F layers are too weakly ionized to reflect signals back to earth. At the peak of the sunspot cycle, however, it is not unusual to have worldwide propagation on frequencies above 30 MHz.
73. What is the range of long-distance radio transmission determined by?
    a. The range of long-distance radio transmission is determined primarily by the ionization density of each layer. The higher the frequency, the greater the ionization density required to reflect radio waves back to Earth. The upper (i.e., E and F) layers reflect the higher frequencies because they are the most highly ionized. The D layer, which is the least ionized, does not reflect frequencies above approximately 500 KHz. Thus, at any given time and for each ionized layer, there is an upper frequency limit at which radio waves sent vertically upward are reflected back to Earth. This limit is called the critical frequency.
74. What happens when radio waves are directed vertically at frequencies higher than the critical frequency?
    a. Radio waves directed vertically at frequencies higher than the critical frequency pass through the ionized layer out into space. All radio waves directed vertically into the ionosphere at frequencies lower than the critical frequency are reflected back to Earth. Radio waves used in communications are generally directed towards the ionosphere at some oblique angle, called the angle of incidence.

Radio waves at frequencies above the critical frequency will be reflected back to Earth if transmitted at angles of incidence smaller than a certain angle, called the critical angle. At the critical angle and all angles larger than the critical angle the radio waves will pass through the ionosphere if the frequency is higher than the critical frequency. When the angle of transmission becomes smaller, the radio waves will be reflected back to Earth.

75. What is skip distance?
    a. The distance from the transmitting antenna to the place where the sky waves first return to Earth is called the skip distance. The skip distance is dependent on the angle of incidence, the operating frequency, and the height and density of the ionosphere. The antenna height, in relation to the operating frequency, affects the angle that transmitted radio waves strike and penetrate the ionosphere and then return to Earth. This angle of incidence can be controlled to obtain the desired area of coverage.
76. What happens when the antenna of a radio is lowered?
    a. Lowering the antenna will increase the angle of transmission and provide broad and even signal patterns in a large area. The use of near-vertical transmission paths is known as near-vertical incidence sky wave (NVIS).
77. What effect does raising the antenna have?
    a. Raising the antenna will lower the angle of incidence. Lowering the angle of incidence can produce a skip zone in which no usable signal can be received. This area is bounded by the outer edge of usable ground wave propagation and the point nearest the antenna at which the sky wave returns to Earth. In most communications situations, the skip zone is not a desirable condition. However, low angles of incidence make long-distance communications possible.
78. What occurs when a transmitted wave is reflected back to the surface of the Earth?
    a. When a transmitted wave is reflected back to the surface of the Earth, part of its energy is absorbed by the Earth. The remainder of its energy is reflected back into the ionosphere to be reflected back again. This means of transmission—by alternately reflecting the radio wave between the ionosphere and the Earth—is called hops, and it enables radio waves to be received at great distances from the point of origin.
79. What is the maximum usable frequency?
    a. There is a maximum frequency at which a radio wave will return to Earth at a given distance when a given ionized layer and a transmitting antenna with a fixed angle of radiation is used. This frequency is called the maximum usable frequency (MUF). It is the monthly median of the daily highest frequency that is predicted for sky wave transmission over a particular path at a particular hour of the day.
80. How does the MUF compare to the critical frequency?
    a. The MUF is always higher than the critical frequency because the angle of incidence is less than 90°. If the distance between the transmitter and the receiver is increased, the maximum usable frequency will also increase. Radio

waves lose some of their energy through absorption by the D layer and the portion of the E layer of the ionosphere at certain transmission frequencies.

81. What frequencies lead to greatest absorption during the day?
    a. The total absorption is less and communications are more satisfactory as higher frequencies are used up to the level of the MUF. The absorption rate is greatest for frequencies ranging from approximately 500 KHz to 2 MHz during the day. At night, the absorption rate decreases for all frequencies.
82. What occurs as sky wave frequency decreases in frequency?
    a. As the frequency of transmission over any sky wave path is decreased from high to low frequencies, a frequency will be reached at which the received signal just overrides the level of atmospheric and other radio noise interference. This is called the lowest useful frequency (LUF) because frequencies lower than the LUF are too weak for useful communications. The LUF also depends on the power output of the transmitter as well as the transmission distance. When the LUF is greater than the MUF, no sky wave transmission is possible.
83. How is radio communications equipment primarily used?
    a. Radio communications equipment is used primarily to transmit voice and data. Although sound can be converted to audio frequency electrical energy, it is not practical to transmit it in this energy form through the Earth's atmosphere by electromagnetic radiation. For example, efficient transmission of a 20-hertz audio signal would require an antenna almost 8,000 kilometers (5,000 mi) long. This would not apply when radio frequency electrical energy is used to carry the intelligence. When radio frequency electrical energy is used, great distances can be covered; efficient antennas for radio frequencies are of practical lengths; and antenna power losses are at reasonable levels.
84. What affets the propogation characteristics of a wave?
    a. The frequency of the radio wave affects its propagation characteristics. In the low frequency band (.03 to.3 MHz), the ground wave is very useful for communications over great distances. The ground wave signals are quite stable and show little seasonal variation. In the medium frequency band (.3 to 3.0 MHz), the range of the ground wave varies from about 24 kilometers (15 mi) at 3 MHz, to about 640 kilometers (400 mi) at the lowest frequencies of this band.
85. When is sky wave reception possible?
    a. Sky wave reception is possible during the day or night at any of the lower frequencies in this band. At night, the sky wave is receivable at distances up to 12,870 kilometers (8,000 mi). In the high frequency band (3 to 30 MHz), the range of the ground wave decreases as frequency increases, and the sky waves are greatly influenced by ionospheric considerations.
86. What are the usable ground waves in the very high frequency band?
    a. In the very high frequency band (30 to 300 MHz), there is no usable ground wave and only slight refraction of sky waves by the ionosphere at the lower frequencies. The direct wave provides communications if the transmitting and receiving antennas are elevated high enough above the surface of the Earth.
87. What waves must be used for all transmissions in the ultrahigh frequency band?

    a. In the ultrahigh frequency band (300 to 3,000 MHz), the direct wave must be used for all transmissions. Communications are limited to a short distance beyond the horizon. Lack of static and fading in these bands makes line of sight reception very satisfactory. Antennas that are highly directional can be used to concentrate the beam of radio frequency (RF) energy, thus, increasing the signal intensity.

88. What transmitters produce RF carriers?
    a. Both amplitude modulation (AM) and frequency modulation (FM) transmitters produce RF carriers. The carrier is a wave of constant amplitude, frequency, and phase which can be modulated by changing its amplitude, frequency, or phase. Thus, the RF carrier "carries" intelligence by being modulated. Modulation is the process of superimposing intelligence (voice or coded signals) on the carrier.
89. What is amplitude modulation?
    a. Amplitude modulation is the variation of the RF power output of a transmitter at an audio rate. In other words, the RF energy increases and decreases in power according to the audio frequencies superimposed on the carrier signal.
90. What causes the generation of additional RF signals?
    a. When audio frequency signals are superimposed on the radio frequency carrier signal, additional RF signals are generated. These additional frequencies are equal to the sum of, and the difference between the audio frequencies and the radio frequency used. For example, assume a 500- KHz carrier is modulated by a 1-KHz audio tone. Two new frequencies are developed, one at 501 KHz (the sum of 500 KHz and 1 KHz) and the other at 499 KHz (the difference between 500 KHz and 1 KHz). If a complex audio signal is used instead of a single tone, two new frequencies will be set up for each of the audio frequencies involved. The new frequencies resulting from superimposing an audio frequency (AF) signal on an RF signal are called side bands.
91. What occurs when the RF carrier is modulated by complex tones?
    a. When the RF carrier is modulated by complex tones such as speech, each separate frequency component of the modulating signal produces its own upper and lower side band frequencies. The side band that contains the sum of the RF and AF signals is called the upper side band. The side band that contains the difference between the RF and AF signals is called the lower side band.
92. What is the space occupied by a carrier and associated side bands?
    a. The space occupied by a carrier and its associated side bands in the radio frequency spectrum is called a channel. In amplitude modulation, the width of the channel (bandwidth) is equal to twice the highest modulating frequency. For example, if a 5,000 KHz (5 MHz) carrier is modulated by a band of frequencies ranging from 200 to 5,000 cycles (.2 to 5 KHz), the upper side band extends from 5,000.2 to 5,005 KHz. The lower side band extends from 4,999.8 KHz to 4,995 KHz. Thus, the bandwidth is the difference between 5,005 KHz and 4,995 KHz, a total of 10 KHz.
93. What is frequency modulation?

    a. Frequency modulation is the process of varying the frequency (rather than the amplitude) of the carrier signal in accordance with the variations of the modulating signals. The amplitude or power of the FM carrier does not vary during modulation.

94. What is the center, or rest, frequency?
    a. The frequency of the carrier signal when it is not modulated is called the center or rest frequency. When a modulating signal is applied to the carrier, the carrier signal will move up and down in frequency, away from the center or rest frequency.
95. What determines how far the carrier signal moves from the center frequency?
    a. The amplitude of the modulating signal determines how far away from the center frequency the carrier will move. This movement of the carrier is called deviation; how far the carrier moves is called the amount of deviation. During reception of the FM signal, the amount of deviation determines the loudness or volume of the signal.
96. What causes variations of a FM signal leaving the transmitting antenna?
    a. The FM signal leaving the transmitting antenna is constant in amplitude but varies in frequency according to the audio signal. As the signal travels to the receiving antenna, it picks up natural and man-made electrical noises that cause amplitude variations in the signal. All of these undesirable amplitude variations are amplified as the signal passes through successive stages of the receiver until the signal reaches a part of the receiver called the limiter. The limiter is unique to FM receivers as is the discriminator.
97. What is the purpose of the limiter?
    a. The limiter eliminates the amplitude variations in the signal, then passes it on to the discriminator which is sensitive to variations in the frequency of the RF wave. The resultant constant amplitude, frequency-modulated signal is then processed by the discriminator circuit which changes the frequency variations into corresponding voltage amplitude variations. These voltage variations reproduce the original modulating signal in a headset, loudspeaker, or teletypewriter. Frequency modulation is generally used by radiotelephone transmitters operating in the VHF and higher frequency bands.
98. What is the principle of single side band communications based on?
    a. The intelligence of an AM signal is contained solely in the side bands. Each side band contains all the intelligence needed for communications. Therefore, one side band and the carrier signal can be eliminated. This is the principle on which single side band (SSB) communications is based. Although both side bands are generated within the modulation circuitry of the SSB radio set, the carrier and one side band are removed before any signal is transmitted.
99. What is the upper side band?
    a. The side band that is higher in frequency than the carrier is called the upper side band (USB). The side band that is lower in frequency than the carrier is called the lower side band (LSB). Either side band can be used for communications as long as both the transmitter and the receiver are adjusted to the same side band.

100. What mode does most SSB equipment operate on?
   a. Most SSB equipment operates in the USB mode. The transmission of only one side band leaves open that portion of the RF spectrum normally occupied by the other side band of an AM signal. This allows more emitters to be used within a given frequency range.
101. Why is single side band transmission is used in applications?
   a. Obtain greater reliability.
   b. Limit size and weight of equipment.
   c. Increase effective output without increasing antenna voltage.
   d. Operate a large number of radio sets without heterodyne interference (e.g., whistles and squeals) from radio frequency carriers.
   e. Operate over long ranges without loss of intelligibility because of selective fading.
102. When can SCR support long range communications?
   a. In the HF band, SCR can support long-range communications. SCR satellite communications (SATCOM) provides mobility, flexibility, and ease of operation with unlimited range. Limitations of SCR include susceptibility to enemy electronic warfare (i.e., cosite, terrain, and atmospheric interference); the requirement for close coordination and detailed planning (i.e., a need for common timing, frequency, and equipment); and limited spectrum availability. The latter is particularly critical in the case of SATCOM.
103. How is MAGTF SCR equipment fielded?
   a. MAGTF SCR equipment is fielded in many configurations and includes hand-held, manpack, vehicle-mounted, bench-mounted, and sheltered radios. These radios operate in simplex and half-duplex modes. The most widely employed tactical radios provide integrated communications security (COMSEC) and jam resistance through frequency hopping. Tactical SCRs operate in the three military radio frequency bands shown in Table 2-1 on page 1-2.
104. What is HF radio equipment capable of?
   a. HF radio equipment is capable of both long- and short-range secure voice and data communications. Data communications capability is typically limited to rates of 2.4 kilobits per second (kbps). Data transmission requires modems specifically designed for operation in this band of the radio spectrum. The AN/PRC-104 is capable of remote operation by using the analog AN/GRA-39B radio remote control. See fig. 2-1.
105. What are high frequency communications capable of?
   a. High frequency communications are capable of traveling around the world under the right conditions. This accounts for the large number of signals and noise in the receiver (e.g., thunderstorms). Conversely, the HF transmission may be intercepted and traced by the enemy who is many hundreds of miles away. VHF and UHF communications are normally limited to line of sight; therefore, their range is restricted. UHF transmissions may also be used in satellite communications, increasing ranges to thousands of miles.
106. What are the primary advantages of using HF radio?

a. The primary advantage of using HF radio is its capability to provide long-range, over the horizon (OTH) communication. Successful data communications over the HF range depends on several factors: equipment siting, proper equipment grounding, types of antennas used, and other considerations such as tactical employment of radio equipment, path assessment and analysis, and frequency planning and assignment. When commercial data terminal equipment (DTE) is used, users employing HF radio equipment need to be aware of radio interference and potential shock hazards that can easily affect unprotected DTE. Whenever possible, HF radio equipment should be remoted from DTE.

107. What are some of the limitations of using HF radios?

a. The primary limiting factors when using HF radios are frequency allocation and management and bandwidth availability. Frequency allocation and management is concerned with frequency, time of day, time of year, and location. The ability to reflect HF radio waves off the ionosphere to a distant location is in a constant state of flux because of activity in the ionosphere. The Sun's radiation causes disturbances in the ionosphere, with most changes taking place in what is known as the F layer (see chapter 1 for more details). Sunrise and sunset can be the most difficult times for HF communications. The F layer splits into two separate layers around sunrise and recombines into one layer around sunset. These splits affect transmission distances as the area "skipped over" increases and decreases. At times, solar storms can eliminate all HF communications. HF transmission paths must be constantly monitored to achieve a dependable HF link. HF radio data communications capabilities are limited by the bandwidth that is imposed by legal constraints and the physics of the spectrum. The bandwidth available in the HF spectrum limits the channel bandwidth, which limits data throughput.

108. What does ground wave propagation involve?

a. Ground wave propagation involves the transmission of a signal along the surface of the ground. The maximum ground wave range for most tactical HF communications is about 20 to 30 kilometers (12 to 22 miles) for manpack equipment and 80 to 100 kilometers for high-power vehicular and van equipment. The range may be decreased by heavy vegetation (e.g., Camp Lejeune), mountainous terrain (e.g., Camp Pendleton), or dry desert soil (e.g., Twenty-nine Palms). A ground wave circuit will generally be free of fading and may last for the entire 24-hour period without the need to change frequencies.

109. What does sky wave propagation involve?

a. Beyond this range, it is necessary to communicate by sky wave. Sky wave propagation involves the bending of the signal by the ionosphere. Frequencies are very important, as those above a certain value will not bend back to earth but will punch through the ionosphere into outer space. On the other hand, lower frequencies are noisier and become absorbed by the ionosphere. The reflective nature of the ionosphere will change when sunlight hits it each day. As a result, at least two frequencies are usually required during a 24-hour period: a low, night frequency and a higher, day frequency.

110. What is a skip zone?

a. A skip zone is where no signals will be received from a particular transmitter for a particular frequency. Skip zones are formed when the nearest point at which a sky wave is received is beyond the furthest point at which a ground wave is received. By using an antenna with a high radiation take-off angle (i.e., the angle measured from the Earth's surface to horizon up to the direction of propagation towards the ionosphere), HF radio waves can be bounced off the ionosphere and come back to earth closer than they can with more commonly used antennas. This can cause the skip zone to disappear if the waves do not punch through.

111. What are near-vertical incident sky wave communications?

a. The use of high radiation take-off angles is called near-vertical incident sky wave (NVIS) communications. The limit of the effective range of NVIS communications is usually about 300 miles. NVIS communications require a horizontally polarized antenna and are done over frequencies between 2 and 12 MHz. Launch angles can be changed by altering the antenna's height above ground, but for most tactical applications one-quarter wavelength above ground is sufficient.

112. Why are NVIS communications useful?

a. NVIS communications are particularly useful because they can be transmitted from moving vehicles. Used correctly, NVIS provides reliable, continuous communications beyond the range of HF ground wave and VHF and UHF line of sight. Multipath interference occurs when both the sky wave and the ground wave signals from the transmitter arrive at different times at the receiver. See figure 2-3. More detailed information on HF propagation and antennas may be found in MCRP 6-22D, Antenna Handbook.

113. What is the SINCGARS?

a. The primary MAGTF VHF radio is the single-channel ground and airborne radio system (SINCGARS). SINCGARS is a family of lightweight combat radios that serves as the primary means of communications for command and control and fire support on the battlefield. SINCGARS is the standard VHF-FM tactical radio for the Marine Corps, replacing the AN/PRC-77 and the AN/VRC-12 family. The system provides high security against threat electronic warfare (EW) by using frequency hopping with integrated COMSEC. It is capable of voice and data transmission (up to 16 kbps under optimum conditions and over limited distances) over the VHF-FM frequency range of 30 to 87.975 MHz.

114. How many different SINCGARS configurations are available?

a. There are seven different SINCGARS configurations available, depending on the requirements of the user. These configurations include the manpack AN/PRC-119 (see figure 2-4 on page 2-8), typically used in infantry operations, and vehicle-mounted variants. The radio provides voice communications ranges of up to 8 km for the manpack and 35 km for vehicular configurations. SINCGARS is capable of remote operation by using the analog AN/GRA-39B radio remote control, the digital HYX-57 wire-line ADAPTER, or the digital C-11561 (C)/U remote control unit (RCU).

115. What improvements have been made to the SINCGARS radio?

a. The SINCGARS radio has undergone a systems improvement program (SIP). This radio is referred to as the SINCGARS SIP. The primary improvements relate to the data transmission capabilities of the system. A forward error correction appliqué was implemented in the receiver and/or transmitter, and a new packet data mode was created to better support packet networks. In addition, an improved channel access protocol was added, which optimizes data throughput performance while minimizing impact on voice communications on the same SINCGARS channel.

116. What is the SINCGARS ASIP?

a. THE SINCGARS SIP radio is also available in a downsized version— the result of an advanced systems improvement program (ASIP). This radio is referred to as the SINCGARS ASIP. This radio will retain all the functionality of the full-size SIP radio but is half the size. It weighs 7.6 pounds (including the battery). The radio is interchangeable with previous SINCGARS versions, including the capability to be mounted in older vehicular adapter assemblies. A new feature of the SINCGARS ASIP provides a retransmission capability while operating in the packet data mode and will also employ a new, fast-channel access protocol for improved operations in shared voice or data nets.

117. What is the AN/ARC-210 multipurpose radio?

a. The AN/ARC-210 multipurpose radio supports single-channel air-to-air, air-to-ground, and ground-to-air communications in tactical Navy and Marine Corps fixed- and rotary wing aircraft. It can transmit and receive VHF-FM, VHF-AM, and UHF signals. It is compatible with SINCGARS, HAVE QUICK, and HAVE QUICK II frequency hopping UHF radios, and it can accept 25 preset, single-channel frequencies. The AN/ ARC-210 requires a TSEC/KY-58 encryption device to encrypt transmissions and decrypt received signals.

118. What are essential for reliable communications?

a. Operator maintenance of the radio equipment, antennas, cable assemblies, and equipment grounding as well as proper planning and selection are essential to reliable communications. Frequency separation, radio antenna separation, remote rekeying when using COMSEC, and power output are significant employment factors. SINCGARS may be limited to the single-channel mode when operating with some Navy ships. When SINCGARS is employed in the frequency hopping mode, the following operating factors need to be taken into account: hopset (i.e., frequency segment allocation), net sych time and mission date, antenna placement (cosite interference is more of a concern than in the single-channel operating mode), and power setting. SINCGARS radios configured for different hopsets that dial into the same numbered net will not be able to communicate. MCRP 6-22A provides detailed information on the employment of SINCGARS.

119. What is the primary communications system for combat elements?

a. VHF SCR is the primary communications system for combat and combat support units while on the move. The predominant mode of operation is secure voice. However, use of VHF radio for data communications will increase with the fielding of tactical information systems at the battalion level and below. Small, hand-held VHF radios are used at the small-unit level in the MAGTF. These radios are often commercial items that lack compatibility with SINCGARS and do not have integrated COMSEC. Their use should be governed accordingly.

120. What are some of the limitations of VHF radios?

   a. The primary limiting factors when using VHF radios are range and frequency availability. VHF radios can provide reliable communications for ranges of up to 10 miles, depending on the equipment operating constraints and the operating environment. Unit location must be considered when employing radios that operate in the VHF spectrum. Most circuits are limited to radio line of sight, known as four-thirds earth curvature. VHF radio signals essentially follow the curvature of the earth to a distance that is approximately one-third greater than the distance to the horizon. Foliage interferes with VHF signals and may reduce normal operating ranges to significantly less than 10 miles.

121. How may VHF comms be used?

   a. The mode of communications used in this range is frequently referred to as frequency modulation. VHF will extend slightly beyond line of sight due to diffraction or bending of the signal by the atmosphere (see fig. 2-5). At frequencies in the 30-MHz range, VHF will often act like HF ground wave. The range of reliable communications is generally no more than 15 to 20 kilometers (9.3 to 12.4 mi) under normal field conditions for manpack equipment. Vehiclemounted equipment may communicate farther because of higher transmitter power and better antennas.

122. What can interfere with VHF LOS?

   a. VHF LOS can also be plagued by multipath interference when the direct ray and a reflected ray traveling over a slightly longer path combine at the receiver antenna so that they periodically cancel or reinforce each other (see fig. 2-6). The signal fades in and out over a period of time as a result. Fading is not as great a problem with immobile equipment because corrective action can be taken, but fading can cause significant problems when one or more of the units are mobile.

123. What frequencies does UHF radio equipment operate within?

   a. Military UHF radio equipment operates in the 116 to 150 MHz upperVHF frequency range and the 225 to 400 MHz military UHF radio spectrum. MAGTF UHF radio sets such as the AN/PRC-113 (see figure 2-7 on page 2-12) are capable of data communications at 16 kbps under optimal conditions. MAGTF ground and airborne UHF radios incorporate the HAVE QUICK Electronic Counter-Counter Measures capability and operate in single-channel and frequency hopping modes. The HAVE QUICK UHF radio is capable of remote operation by using the AN/ GRA-39B or HYX-57.

124. Where may UHF radios be used?

   a. UHF radios are used for forward air control (FAC) ground-to-air communication. Line of sight between radios is critical for reliable communications. Significant range differences are encountered between UHF radios employed for ground-to-air and ground-to-ground communications. Greater range is achieved when employed from ground-to-air because of the increased line of sight. When UHF radios are employed in the frequency hopping mode, the following operating factors must be understood for proper operation: hopset, time of day, antenna placement, and power setting.

125. What is the primary limiting factor when using UHF radios?
    a. The primary limiting factor when using UHF radios is range (i.e., critical line of sight). Critical line of sight can be described as "what you see is what you get." As long as the radio's antenna has optical line of sight to another radio's antenna, the two will be able to transmit and receive. For this reason, UHF radios are used primarily in air-to-ground communications.

126. What is the purpose of the Tactical Communications Interface Module?
    a. The TCIM provides the communications link between the tactical computers of the communications and information systems within the MAGTF and the local and wide area networks, switched backbone (SBB), and radio nets. There are two versions of the TCIM card: an internal personal computer asynchronous transfer card to mount directly in the computer, and an external version with the card mounted in a portable chassis. TCIM software was developed for open-systems architectures. Small computer systems interfaces (SCSI) provide interoperability between the TCIM and other Marine Corps computers.

127. What two factors play an important role in communication equipment siting?
    a. Two factors play an important role in equipment siting: optimum communications and camouflage. It is often difficult to find communications sites which are hidden from enemy view, fire, and direction finding and afford good communications connectivity. The ideal location for a radio antenna is as far away from cover as possible, such as a bare mountain top or in the middle of a large field. However, this goes against the commander's tactical requirement for troops and equipment to be camouflaged and concealed as much as possible. Therefore, planning the location of equipment must be detailed to achieve the best results. See Appendix A for a review on topographical maps and grid coordinates.

128. What are some guidelines for using ground wave links near hills?
    a. In the presence of hills (without large trees), the following guidelines for ground wave links should be used:
    b. Locate HF antennas just below the top of the hill in the direction of desired communications. Often the signal will be greater below than on the top. This will also minimize interference and/or jamming from the opposite direction.
    c. Move the antenna back from the hill if a hill is between the operator and the distant station with which the operator wishes to communicate. The signal strength can vary widely in the region immediately behind a hill. If it is necessary to set up behind a hill, then it may also be necessary to set up a variety of antennas located at different distances from the hilltop to see which one offers the best performance.

129. How are Long-distance, HF sky wave signals often best received?

a. Long-distance, HF sky wave signals of more than several hundred kilometers are often best transmitted and received at angles just above the horizon level. Obstacles on the horizon will cause the signal to travel a higher path angle and may reduce the circuit reliability as a result (see fig. 3-1). Wire fences between the operator and the horizon will also lessen the chances of getting through (see fig. 3-2). An HF ground wave signal will follow the terrain much better than higher frequency signals. It will be weakened by trees (more so when they have leaves) and rugged terrain, but the signal may still get through (see fig. 3-3).

130. What obstacle may weaken or stop a radio signal?

a. Obstacles such as trees, buildings, and hills between a transmitter and receiver will weaken the signal or stop it. Aircraft flying along the path will also interfere with reception (see fig. 3-4). A clear signal path between the transmitter and the intended receiver, especially for LOS communications, is preferred. The antenna must be positioned as high as possible to overcome obstacles, especially if communication is in the direction of trees or buildings (see fig. 3-5). Keep equipment as far back as possible from obstacles in the direction of the signal path to prevent interference or damage to equipment.

131. How can a solid obstacle actually improve a radio link?

a. In some situations, solid obstacles may actually improve a link by providing a sharper surface to diffract over or reflect from (see fig. 3-6). Under certain conditions, spherical water towers and walls of buildings (facing the proper direction) may enable communication around interfering terrain or vegetative obstacles (see fig. 3-7). Transmitting over water allows VHF to go farther, but fading may occur. If communicating over water is unavoidable, and fading occurs, the signal may be improved by raising or lowering the antenna. The antenna may also be positioned so a hill or rise is between it and the water but not high enough to block the LOS to the other antenna (see fig. 3-8).

132. What commo equipment may easily give up your location?

a. Nothing is more compromising to a unit's location than an antenna farm stretched along a ridge line (see fig. 3-9). The enemy will realize that a major command post is nearby. The advantage of placing an antenna on a ridge line is the ability to talk in many directions without land being in the way.

133. What are methods you can use to minimize the chances of signal interception?

a. If communication is needed in only one direction—away from the enemy—put some terrain shielding between the antenna farm and the enemy (see figures 3-10 and 3-11). This way, the enemy won't be able to intercept communications or jam circuits as easily. However, it's not always necessary to talk from hilltop to hilltop. Talking from hillside to hillside or along the valley floor may be a better option in some instances. The enemy will certainly have a harder time locating a unit this way.

134. How can the body impact radio comms?

a. The body can act as an antenna and affect the quality of the radio signal, particularly backpack and hand-held VHF sets with short antennas. The effect of the body on signal strength depends on frequency, antenna length, and the position of the antenna or set relative to the operator's body (see fig. 3-12 on page 3-8).

135. What are considerations for the use of Backpack Sets (AN/PRC-119)?

   a. Maximum radiation (i.e., best performance) is to the front when the set is on the operator's back with a 3-foot whip antenna. The operator should then try facing in the direction of distant communications. This effect is most noticeable at frequencies greater than 50 MHz. When the set is on the ground, and the operator is very close to the set, maximum radiation will probably occur through the operator's body. If the operator is a couple of feet away, the operator may act as a reflector and either improve or interfere with the signal.

136. What are considerations for the use of Hand-Held Sets (AN/PRC-68)?

   a. The antenna of the hand-held AN/PRC-68 is much smaller than the AN/PRC-119's, and the operator's body affects directional characteristics to a greater extent, particularly when the antenna is lowered. This radio will normally be in the front jacket pocket, and best performance is then over the back. The higher frequencies are strongly affected when the antenna is lowered. Holding the radio in hand a few inches away from the body will modify the radiation pattern and can substantially lower performance to the sides at the higher frequencies. The directional characteristics of the antenna-body combination can be used to some advantage in reducing interference arriving from directions other than that of the signal. Trial and error is necessary to make this judgment.

137. What are considerations for VHF Siting?

   a. Position the antenna to reflect the directive pattern away from the wall or fence in the intended direction of communication when using VHF antennas near a metal-walled building or high, metal fence. For frequencies between 30 and 50 MHz, the antenna should be placed approximately 2 meters (6.5 feet) away; between 50 and 88 MHz, no more than 1 meter (3.2 feet) away. Communications may be reduced if antennas are placed more than 2 meters from the radio. The distance may be varied a foot or so in each direction, while receiving, to find the position where the signal is the strongest when setting up the equipment. If frequencies are changed later, the optimum position will have to be redetermined at that time by the same method.

138. What can weaken UHF and VHF frequencies?

   a. At UHF and (to a much lesser degree) VHF frequencies, if an operator cannot see a person, then they probably cannot communicate—especially in heavy vegetation. Often, the signal has to travel up to the tops of the trees and move along the treetops and down to the receiver (see fig. 3-13). This will weaken it considerably. In vegetation, the antenna should be positioned away from trees that are in the direction of the signal and erected as high as possible. Changing the location of the antenna is also an option. Both horizontal and vertical orientations may be used with the AS-4225 Parabolic Grid Antenna with UHF multi-channel (MUX) radio equipment. Horizontal polarization is usually better for passing through the trees, but if the signal is skimming over the tops of the trees (probably unnoticeable) or over water, then the polarization should be vertical (see fig. 3-14 on page 3-10).

139. What is the most important cause of a weak HF signal?

a. Poor grounding is probably the most important cause of a weak HF signal. Communication distances can easily be cut in half by improper grounding of the antenna. More importantly, the hazards involved with improper grounding coupled with high transmitter powers are bad burns, electrical shocks, or even death (see fig. 3-15).

140. What is the purpose of grounding?

a. Grounding prevents electrical shock to operator and improves signal strength, particularly in HF.

141. How should the ground stake be placed into the ground?

a. The ground stake provided with the antenna should be driven deeply into the soil, making certain all connections are tight and clean. Soil moisture and salinity around the ground stake are very important for good grounding. If a dry or a damp location is available, choose the damp spot. If everything is bone dry, a couple of gallons of water poured around the stake may help. Adding a pound or two of salt from the mess tent to the soil around the stake before soaking it may help even more. If a regulation ground stake is not available, there are many field-expedient means for grounding. The primary concern is to provide an electrical path from the equipment case, using braided copper or heavy gauge wire, to a buried metallic object that is in good contact with the ground. All cable connections and grounds should be free of grease, paint, or rust. Cables should be as short as possible.

142. What are some examples of useful ground?

a. Some useful grounds are—
b. Metal fence posts.
c. Steel reinforcing rods.
d. Metal pipes.
e. Metal plumbing (must not be connected to flammable liquid or gas).
f. Metal building frames.

143. Why is a groudn radial system necessary?

a. A ground radial system (i.e., counterpoise) is necessary to reduce the amount of power lost in the earth (see fig. 3-16). This is particularly important for HF whips, inverted As, and other vertical antennas. The radial system design is usually a compromise between performance, portability, and time to install the system. Ground radials help to establish a known reference point of electrical ground. Without them, electrical ground may be some distance beneath the Earth's surface. Known electrical ground is important not only for formation of the wavefront off the antenna, but it also affects launch angles from antennas.

144. How are radials used?

a. Radials are attached metal-to-metal to a central point (a metal plate is often convenient). The radio frequency (RF) ground is attached to the central plate (Figure 3-17). Wire diameter is not critical; select a diameter small enough to be lightweight and transportable, but large enough to prevent breakage. The largest number of radials to transport should be consistent with weight and bulkiness limitations. It is not necessary to make them greater than one-quarter wavelength at the lowest operating frequency

145. When may a vertical whip antenna be used?
    a. A vertical whip antenna (i.e., whip) will most likely be used with an HF radio. The whip is particularly good for ground wave communications in many directions at one time, at distances of 20 to 30 kilometers. Unfortunately, while it is radiating in all directions at the same time, it is also picking up interference from all directions. It is useless if using sky wave over a distance of 100 kilometers, because of the high radiation angles required. (NOTE: Launch angles off vertically polarized whip antennas are maximum below 45°.) A vertical whip's performance by sky wave, however, improves with increased path distances.
146. How can vehicle whips be employed in HF comms?
    a. A vehicle-mounted whip, tied down fairly close to the vehicle, may be efficiently employed in short- and intermediate-distance HF sky wave communications. A whip, tied back only a little, may be useful in longdistance HF sky wave applications.
147. When may a sloping wire be used?
    a. If an HF circuit is only a single point-to-point ground link or a ground wave net with all other terminals being located in the same direction, a sloping wire may be used, if available. The radiating length of the AT984 "Fishreel" antenna (a 45-foot long, wire antenna which can be used with the AN/PRC-104) can be varied by either connecting or disconnecting the alligator clips. (Antenna length is measured from the radio equipment.) See Table 4-1 to determine how long an antenna should be cut to form an assigned frequency.
148. When may the OE-254 be used?
    a. This antenna is used with VHF-FM radios to increase the operating range beyond that of a normal whip. The two elements hanging down from the antenna form a ground-plane similar to the ground radials discussed in chapter 3. The effect is to act as an artificial ground and greatly increase the signal range. The antenna radiates in all directions at the same time. The OE-254's elements allow it to tune to frequencies between 30 and 88 MHz without manually adjusting either the groundplane or radiating elements' length. Figure 4-5 illustrates the OE-254 antenna.
149. What are considerations for Vertical Whip antennas?
    a. VHF whip antennas are usually limited in range from 15 to 20 miles. A whip antenna is omnidirectional; therefore, it has the potential to produce a great deal of radio-wave interference with the radios in the area. It is important when using a whip antenna or any antenna to keep maximum distance between antennas. Use of hills and other terrain features to block off unwanted signals will improve desired signal strength. When using whip antennas with backpack or hand-held equipment, body position may increase the transmitted and received signal. This is because the human body acts as an antenna. If experiencing communication

problems, the operator should try facing in different directions to improve the reception of the signal.

150. What are the considerations for antenna length?
    a. The length of an antenna must be considered in two ways. It has both a physical and an electrical length, and the two are never the same. The reduced velocity of the wave on the antenna and a capacitive effect (known as end effect) make the antenna seem longer electrically than it is physically. The contributing factors are the ratio of the diameter of the antenna to its length and the capacitive effect of terminal equipment (e.g., insulators, clamps, etc.) used to support the antenna. To calculate the physical length of an antenna, use a correction of 0.95 for frequencies between 3.0 and 50.0 MHz. The following figures are for a half-wave antenna.

151. What are the two principal sources of natural radio noise?
    a. Natural radio noise has two principal sources: thunderstorms (atmospheric noise) and stars (galactic noise). It is especially noticeable at night when the lower frequencies propagate farther than in the daytime. The only way to reduce this type of interference is to use a directional antenna to prevent receiving the interference from all directions. However, this will not eliminate the noise coming from the direction of the received signal. Use of a higher frequency will also help, although if a sky wave circuit is used, care must be exercised not to pick the highest frequency at which the signal will be refracted to Earth by the ionosphere (i.e., the critical frequency).

152. Where does most manmade interference come from?
    a. Most manmade interference comes from electrical sources such as power generators, alarm systems, power lines, auto ignition, fluorescent lighting, faulty electrical relay contacts, and electrified railroads. Manmade interference also includes enemy jammers (see chapter 7). The key to combating this form of interference is to isolate communications equipment from manmade interference. The interference from known sources such as generators can be greatly reduced if an antenna is positioned so that an obstacle (e.g., a hill) is between it and the source. This must be done so that the same obstacle will not block the intended radio path. If the interference is not coming from the same direction as the intended signal, then a directional antenna should be used.

153. What may also result in radio interference?
    a. The condition of radio equipment and how it is being used may result in interference. There are several steps that should be taken to lessen this possibility. These include making certain that shielded cables are used where required, ensuring connectors are properly connected to cables, and making sure that antennas within a group are as far apart as possible. All antenna leads (transmission lines), power lines, and telephone lines should be as short as possible when they are on the ground and should not cross. If lines do cross, they must cross at 90° angles to each other, and they must be separated from each other by standoffs. Lines threaded through the trees near an antenna serve

as pipelines for interference to and from antennas. Finally, ensure that all radio equipment is grounded.

154. What may frequency interference be caused by?

a. Frequency interference is one of the easiest communications problems to prevent, but it must be done by the CIS officer, CIS chief, and frequency manager during the development of the CIS plan. This type of interference is caused primarily by two radio transmitters using the same frequency, but it can also happen when different frequencies are used. Most of these problems can be eliminated by good frequency planning.

155. What steps can be taken to improve comms in the event of frequency interference?

a. However, if frequency interference does occur the following steps can be taken to improve communications:
b. Identify the source of the interference. If it is a VHF or HF ground wave transmission, it will probably be within the immediate area and will only occur when the offending transmitter is keyed. The other operator is probably transmitting on a different frequency and has no way of knowing that he is interfering with anyone else's ability to transmit.
c. Get the interfering operator to lower their transmitter power as long as it does not degrade their circuit.
d. Put as much distance as possible between the affected unit's equipment. This may involve using a hill or other object to block the signal.
e. Change to a directional antenna.
f. Remember that the receiver of interference may also cause someone else interference and, whenever possible, should lower his power and use a directional antenna.
g. Report interference to the CIS officer or CIS chief.

156. What are unauthorized frequencies?

a. There is one final source of frequency interference: the use of unauthorized frequencies. This practice is illegal and has the potential to disrupt a carefully engineered frequency plan, introduce interference to other frequencies and circuits, and prevent other units from fulfilling their mission. Radio operators should never use unauthorized frequencies.

157. There are not enough radio frequencies available for all radio operators to have their own channel. What does this mean?

a. When HF propagation conditions are favorable, Marines may discover that their radio frequency is being used by foreign or United States military personnel in other countries. VHF FM frequencies often have to be reused within the same operation by more than one unit. The exercise frequency manager will try to make certain that users of the same frequency are as far away as possible from each other, but some units (United States Marine Corps and Army, in particular) will join at some stage in the operation. When this occurs, the first common, higher headquarters should be informed to settle the problem.

158. What is the primary communication method in the desert?

a. SCR is usually the primary means of communications in the desert. It can be employed effectively in desert climate and terrain to provide the highly mobile means of communications demanded by widely dispersed forces. However, desert terrain provides poor electrical ground, and counterpoises are needed to improve operation.

159. Where should radio antennas be located for best operation in the desert?

a. For the best operation in the desert, radio antennas should be located on the highest terrain available. Transmitters using whip antennas in the desert will lose one-fifth to one-third of their normal range because of the poor electrical grounding characteristics of desert terrain. For this reason, it is important to use complete antenna systems such as horizontal dipoles and vertical antennas with adequate counterpoises.

160. What may some SCRs do if the internal temperature rises too high?

a. Some SCRs automatically switch on their second blower fan if their internal temperature rises too high. Normally, this happens only in temperate climates when the radios are transmitting. This may disturb Marines unaccustomed to radio operation in the desert environment. Operation of the second fan, however, is quite normal. RF power amplifiers used in AM and SSB sets are liable to overheat severely and burn out. They should be turned on only when necessary (signal reception is not affected). Since the RF power amplifiers take approximately 90 seconds to reach the operating mode, the standing operating procedure (SOP) of units using the equipment should allow for delays in replying.

161. How can dust affect communication equipment?

a. Dust affects communications equipment such as SSB/AM RF power amplifiers. Dust covers should be used whenever possible. Some receiver-transmitter units have ventilating ports and channels that can get clogged with dust. These must be checked regularly and kept clean to prevent overheating.

162. How can heat affect wet cell batteries?

a. Wet cell batteries do not hold their charge efficiently in intense heat. Electrolyte evaporates rapidly and should be checked weekly (more often, if warranted). Add distilled water as needed. Extra containers of distilled water should be carried in the vehicle. Maintenance of vehicle batteries, beyond adding water, must be done only by authorized motor-transport personnel according to applicable Marine Corps Orders and SOPs. Dry battery supplies must be increased, since hot weather causes batteries to fail more rapidly.

163. How can wind and sand damage communications equipment?

a. Wind-blown sand and grit will damage electrical wire insulation over a period of time. All cables that are likely to be damaged should be protected with tape before insulation becomes worn. Sand will also find its way into parts of items such as "spaghetti cord" plugs, either preventing electrical contact or making it impossible to join the plugs. Carry a brush, such as an old toothbrush, and use it to clean such items before they are joined.

164. How can condensation damage communications equipment?

a. In deserts with relatively high dew levels and high humidity, overnight condensation can occur wherever surfaces (such as metals exposed to air) are cooler than the air temperature. This condensation can affect electrical plugs, jacks, and connectors. All connectors likely to be affected by condensation should be taped to prevent moisture from contaminating the contacts. Plugs should be dried before inserting them into equipment jacks. Excessive moisture or dew should be dried from antenna connectors to prevent arcing.

165. How can static electricity in the desert impact communications equipment?
    a. Static electricity is prevalent in the desert. It is caused by many factors, e.g., wind-blown dust particles. Extremely low humidity contributes to static discharges between charged particles. Poor grounding conditions exacerbate the problem. Be sure to tape all sharp edges (tips) of antennas to cut down on wind-caused static discharges and the accompanying noise. If you are operating from a fixed position, ensure that equipment is properly grounded. Since static-caused noise diminishes with an increase in frequency, use the highest frequencies that are available and authorized.
166. When can the maintenance of SCRs become difficult in desert areas?
    a. In desert areas, the maintenance of SCRs becomes more difficult because of the large amounts of sand, dust, or dirt that enter the equipment. Radios equipped with servomechanisms are particularly affected. To reduce maintenance downtime, keep the radios in dustproof containers as much as possible. It is also important to keep air vent filters clean to allow cool air to circulate to prevent overheating. Preventive maintenance checks should be made frequently. Also, keep a close check on lubricated parts of the equipment. If dust and dirt mix with the lubricants, moving parts may be damaged.
167. Why must SCR communications in jungle areas be carefully planned?
    a. SCR communications in jungle areas must be carefully planned because the dense jungle growth significantly reduces the range of radio transmission. However, since SCR can be deployed in many configurations, especially manpacked, it is a valuable communications asset. Mobility is also an advantage of SCR. The capabilities and limitations of SCR must be carefully considered when used by forces in a jungle environment. Climate and density of jungle growth limits SCR communications in jungle areas. The hot and humid climate increases the maintenance problems of keeping equipment operable. Thick jungle growth acts as a vertically polarized absorbing screen for RF energy that reduces transmission range. Therefore, increased emphasis on maintenance and antenna siting is necessary when operating in jungle areas.
168. What is the main issue in establishing SCR communications in jungle areas?
    a. The main problem in establishing SCR communications in jungle areas is the siting of the antenna.
    b. Apply the following techniques to improve communications in the jungle:
    c. Antennas should be located in clearings on the edge farthest from the distant station and as high as possible.

d. Antenna cables and connectors should be kept off the ground to lessen the effects of moisture, fungus, and insects. This also applies to all power and telephone cables.
e. Complete antenna systems, such as ground planes and dipoles, are more effective than fractional wavelength whip antennas.
f. Vegetation must be cleared from antenna sites. If an antenna touches any foliage, especially wet foliage, the signal will be grounded.
g. Vegetation, particularly when wet, acts like a vertically polarized
h. screen and absorbs much of a vertically polarized signal. Horizontally polarized antennas are preferred to vertically polarized antennas.

169. What makes maintenance of SCRs difficult in jungle areas?
   a. Because of moisture and fungus, the maintenance of SCR in tropical climates is more difficult than in temperate climates. The high relative humidity causes condensation to form on the equipment and encourages the growth of fungus.
170. What are some techniques for improving maintenance in jungle areas?
   a. Keep the equipment as dry as possible and in lighted areas to retard fungus growth.
   b. Keep all air vents clear of obstructions so air can circulate to cool and dry the equipment.
   c. Keep connectors, cables, and bare metal parts as free of fungus growth as possible. Use moisture fungusproofing paint (MFP) to protect equipment after repairs are made or when equipment is damaged or scratched.
171. How can dismounted units improve communications in the jungle?
   a. Dismounted patrols and units of company size and below can greatly improve their ability to communicate in the jungle by using expedient antennas. While moving, they are generally restricted to using the short and long antennas which come with the radios. However, when they are not moving, these expedient antennas will allow them to broadcast farther and receive more clearly.
172. What are one of the most important capabilities of SCR in cold weather?
   a. SCR equipment has certain capabilities and limitations that must be carefully considered when operating in extremely cold areas. However, in spite of significant limitations, SCR is the normal means of communications in such areas. One of the most important capabilities of SCR in cold weather areas is its versatility. Vehicular-mounted radios can be moved relatively easily to almost any point where it is possible to install a command headquarters. Smaller, manpacked radios can be carried to any point accessible by foot or aircraft. A limitation on radio communications that radio operators must expect in extremely cold areas is interference by ionospheric disturbances. These disturbances, known as ionospheric storms, have a definite degrading effect on sky wave propagation. Moreover, either the storms or the auroral (e.g., Northern Lights) activity can cause complete failure of radio communications. Some frequencies may be blocked out completely by static for extended periods of time during storm activity.
173. What is fading? When does it occur?

a. Fading, caused by changes in the density and height of the ionosphere, can also occur and may last from minutes to weeks. The occurrence of these disturbances is difficult to predict. When they occur, the use of alternate frequencies and a greater reliance on FM or other means of communications are required.

174. What issues may cold weather provide for establishing communications platforms?

a. Because of permafrost and deep snow, it is difficult to establish good electrical grounding in extremely cold areas. The conductivity of frozen ground is often too low to provide good ground wave propagation. To improve ground wave operation, use a counterpoise to offset the degrading effects of poor electrical ground conductivity. Remember to install a counterpoise high enough above the ground so that it will not be covered by snow. In general, antenna installation in arcticlike areas presents no serious difficulties. However, installing some antennas may take longer because of adverse working conditions.

175. What are a few tips for installing antennas in extremely cold areas?

a. Mast sections and antenna cables must be handled carefully since they become brittle in very low temperatures. Antenna cables should be constructed overhead to prevent damage from heavy snow and frost, whenever possible. Nylon rope guys, if available, should be used in preference to cotton or hemp because nylon ropes do not readily absorb moisture and are less likely to freeze and break. Antennas should have extra guy wires, supports, and anchor stakes to withstand heavy ice and wind loading.

176. What can cause frequency drift?

a. Low battery voltage can also cause frequency drift. When possible, allow a radio to warm up several minutes before placing it into operation. Since extreme cold tends to lower output voltage of a dry battery, try warming the battery with body heat before operating the radio set. This minimizes frequency drift. Flakes or pellets of highly electrically charged snow are sometimes experienced in northern regions. When these particles strike the antenna, the resulting electrical discharge causes a high-pitched static roar that can blanket all frequencies. To overcome this static, antenna elements can be covered with polystyrene tape and shellac.

177. What difficulties arise when using SCR equipment in extreme cold?

a. The maintenance of SCR equipment in extreme cold presents many difficulties. Radios must be protected from blowing snow, since snow will freeze to dials and knobs and blow into the wiring to cause shorts and grounds. Cords and cables must be handled carefully since they may lose their flexibility in extreme cold. All radio equipment and power units must be properly winterized. Check the appropriate technical manual (TM) for winterization procedures. A few tips for maintenance in arctic areas are discussed in the following paragraphs.

178. How can low temperature impact your communications platforms?

a. Power Units. As the temperature goes down, it becomes increasingly difficult to operate and maintain generators. They should be protected as much as possible from the weather.

b. Batteries. The effect of cold weather on wet and dry cell batteries depends upon the type and kind of battery, the load on the battery, the particular use of the battery, and the degree of exposure to cold temperatures.
c. Shock Damage. Damage may occur to vehicular SCR by the jolting of the vehicle. Most synthetic rubber shock mounts become stiff and brittle in extreme cold and fail to cushion equipment. Check the shock mounts frequently and change them, as required.
d. Winterization. Check the TMs for the SCR and power source to see if there are special precautions for operation in extremely cold climates. For example, normal lubricants may solidify and permit damage or malfunctions. They must be replaced with the recommended arctic lubricants.

179. How are microphones affected during cold weather operations?

a. Microphones. Moisture from your breath may freeze on the perforated cover plate of your microphone. Use standard microphone covers to prevent this. If standard covers are not available, improvise a suitable cover from rubber or cellophane membranes or from rayon or nylon cloth.

180. What is the process of breathing for a radio? How can it impact the radio? How can the effects of radio sweating be minimized?

a. Breathing and Sweating. A SCR generates heat when it is operated. When it is turned off, the air inside cools and contracts and draws cold air into the set from the outside. This is called breathing. When a radio breathes, and the still-hot parts come in contact with subzero air, the glass, plastic, and ceramic parts of the set may cool too rapidly and break. When cold equipment is brought suddenly into contact with warm air, moisture will condense on the equipment parts. This is called sweating. Before cold equipment is brought into a heated area, it should be wrapped in a blanket or parka to ensure that it will warm gradually to reduce sweating. Equipment must be thoroughly dry before it is taken back out into the cold air or the moisture will freeze.

181. What problems arise during use of vehicle mounted radios?

a. Vehicular-Mounted Radios. These radios present special problems during winter operations because of their continuous exposure to the elements. Proper starting procedures must be observed. The radio's power switch must be off prior to starting the vehicle; this is a particularly critical requirement when vehicles are slave started. If the radio is cold soaked from prolonged shutdown, frost may have collected inside the radio and could cause circuit arcing. Hence, time should be allowed for the vehicle heater to warm the radio sufficiently that any frost collected within the radio has a chance to thaw. This may take up to an hour. Once the radio has been turned on, it should warm up for approximately 15 minutes before transmitting or changing frequencies. This allows components to stabilize. If a vehicle is operated at a low idle with radios, heater, and lights on, the batteries may run down. Before increasing engine revolutions per minute to charge the batteries, radios should be turned off to avoid an excessive power surge. A light coat of silicon compound on antenna mast connections helps to keep them from freezing together and becoming hard to dismantle.

182. How can mountainous areas provide problems?
   a. Operation of SCRs in mountainous areas has many of the same problems as in northern or cold weather areas. Also, the mountainous terrain makes the selection of transmission sites a critical task. In addition, the terrain restrictions encountered frequently make radio relay stations necessary for good communications.
183. When may SCR transmissions have to be line of sight?
   a. Because of terrain obstacles, SCR transmissions will frequently have to be by line of sight. Also, the ground in mountainous areas is often a poor electrical conductor. Thus, a complete antenna system, such as a dipole or ground-plane antenna with a counterpoise, should be used. The maintenance procedures required in mountainous areas are very often the same as maintenance in northern or cold weather areas. The varied or seasonal temperature and climatic conditions in mountainous areas make flexible maintenance planning a necessity.
184. What problems do SCR communications pose in urbanized terrain?
   a. SCR communications in urbanized terrain poses special problems. Some problems are similar to those encountered in mountainous areas. There are problems of obstacles blocking transmission paths. There is the problem of poor electrical conductivity because of pavement surfaces. There is also the problem of commercial power-line interference. VHF radios are not as effective in urbanized terrain as they are in some other areas. The power output and operating frequencies of these VHF radios require a line of sight between antennas. Line of sight at street level is not always possible in built-up areas.
185. Why do HF radios rely on LOS less that VHF radios?
   a. HF radios do not require or rely on line of sight as much as VHF radios because operating frequencies are lower, and power output is greater. The problem is that HF radios are not organic to small units. To overcome this, the VHF signals must be retransmitted.
186. What provides the most effective means of retransmissions?
   a. Retransmission stations in aerial platforms can provide the most effective means if they are available. Organic retransmission is more likely to be used. The antenna should be hidden or blended in with surroundings. This will help prevent the enemy from using it as a landmark to "home in" his artillery bombardment. Antennas can be concealed by water towers, existing civilian antennas, or steeples.
187. What steps can be taken to increase radio effectiveness in urban operations?
   a. The following steps should also be taken within urbanized terrain:
   b. Park radio-equipped vehicles inside buildings for cover and concealment.
   c. Dismount radio equipment and install it inside buildings (in basement, if available).
   d. Place generators against buildings or under sheds to decrease noise and provide concealment (adequate ventilation must be provided to prevent heat buildup and subsequent failure of generator).
188. How do nuclear weapons impact communications platforms?

    a. One of the realities of fighting on the modern battlefield is the presence of nuclear weapons. The explosion of a nuclear weapon causes a tremendous blast, followed by intense heat and strong radiation. The ionization of the atmosphere by a nuclear explosion will have degrading effects on communications because of static and the disruption of the ionosphere.

189. What are more effects of nuclear explosions?
    a. Another effect of a nuclear explosion that is an even greater danger to radio communications is the electromagnetic pulse (EMP). EMP is a strong pulse of electromagnetic radiation, many times stronger than the static pulse generated by lightning. This pulse can enter the radio through the antenna system, power connections, and signal input connections. In the equipment, the pulse can break down circuit components such as transistors, diodes, and integrated circuits. It can melt capacitors, inductors, and transformers. EMP can destroy a radio.

190. What are defensive measures that can be taken EMPs?
    a. Defensive measures against EMP call for proper maintenance, particularly the shielding of equipment. When the equipment is not in use, all antennas and cables should be removed to decrease the effect of EMP on the equipment. Effective grounding is necessary to reduce effect of EMP. EMP is a danger to SCR equipment, but contamination is a danger to Marines. Contamination from any portion of the nuclear, biological, and chemical (NBC) environment has adverse effects on both equipment and personnel.

191. What is electronic warfare?
    a. Electronic warfare (EW) is the military action involving the use of electromagnetic energy (i.e., radio frequency waves) to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability. EW includes electronic attack (EA), electronic protection (EP), and electronic warfare support (ES).

192. What actions are taken during an electronic attack?
    a. EA includes actions taken to prevent or reduce the enemy's effective use of the electromagnetic spectrum and employment of weapons that use electromagnetic or directed energy. EP represents actions taken to protect personnel, facilities, and equipment from any effects of friendly or enemy employment of electronic warfare that degrade, neutralize, or destroy friendly combat capability. ES involves actions taken by, or under direct control of, an operational commander to search for, intercept, identify, and locate sources of intentional or unintentional radiated electromagnetic energy for the purpose of immediate threat recognition. Each radio operator must be aware of what the enemy will try to do. The enemy is well equipped to conduct EW, and the different techniques the enemy uses have specific purposes in the enemy's EW effort.

193. How many enemy forces try to exploit friendly use of the electromagnetic spectrum?
    a. Enemy forces employ a large number of radio direction finder (RDF) sets and communications intelligence (COMINT) analysts to exploit friendly use of the electromagnetic spectrum. The enemy's goal is to locate and destroy as many command and control, fire support, and intelligence sites as possible during the

first critical phase of the battle. When the enemy locates sites that the enemy cannot or does not want to destroy, these sites become prime targets for imitative electronic deception (IED) or jamming. Imitative electronic deception is the enemy's use of a compatible radio and a language expert to enter a friendly radio net. The enemy IED experts are very good at their jobs. If they are permitted to enter into a net, they will create much confusion for friendly forces.

194. What is an effective way to disrupt control of the battle?
   a. Jamming is an effective way to disrupt control of the battle. All it takes is a transmitter, tuned to your frequency, with the same type of modulation and with enough power output to override the signal at your receiver.

195. Why must radio operators be aware of enemy jamming efforts?
   a. There are many types of jamming signals that may be used against a radio operator. Some are very difficult to detect and some are impossible to detect. For this reason, an operator must always be alert to the probability of jamming and react accordingly when the radio has been silent for an inordinate amount of time. The radio operator should also be able to quickly identify the various types of jamming signals.

196. The radio operator should also be able to quickly identify the various types of jamming signals. What are some different types of jamming signals?
   a. These include—
   b. Random noise.
   c. Random pulse.
   d. Stepped tones.
   e. Wobbler.
   f. Random keyed modulated continuous wave.
   g. Tone.
   h. Rotary.
   i. Pulse.
   j. Spark.
   k. Recorded Sounds.
   l. Gulls.
   m. Sweep-through.

197. What is an inherent characteristic in FM communication?
   a. An inherent characteristic in FM communications is that a given station transmitting a signal will capture those receivers on the same frequency and in range for the receiver to detect the signal. This is the basis for netted communications for VHF FM radios. This FM capture effect is undesirable when receivers in a net are "captured" by a transmitter not in that net. This could be friendly interference or enemy interference. Friendly interference is usually unintentional whereas enemy interference is usually intentional.

198. What is the purpose of obvious interference?
   a. Radio operators are mostly aware of obvious interference (e.g., jamming) by an enemy, such as stepped tones (e.g., bagpipes), randomkeyed Morse Code, pulses, and recorded sounds. The purpose of this type of jamming is to block out

reception of friendly transmitted signals and to cause a nuisance to the receiving operator. An operator can usually detect when the enemy is using this type of jamming.

199. What are the characteristics of subtle jamming?
    a. This type of jamming is not obvious at all. With subtle jamming, no sound is heard from the receiver. The radio does not receive incoming friendly signals, yet everything seems normal to the operator.

200. Why must radio operators be able to determine if their radios are being jammed?
    a. Radio operators must be able to determine whether or not their radios are being jammed. This is not always easy. Threat jammers may employ obvious or subtle jamming techniques. These techniques may consist of powerful unmodulated or noise-modulated carrier signals transmitted to the operator's receiver. Unmodulated jamming signals are characterized by a lack of noise. Noise-modulated jamming signals are characterized by obvious interference noises. If radio operators suspect that their radios are the targets of threat jamming, the following procedures will help them to make this determination.

201. What actions are taken once the radio operator suspects jamming or enemy intrusion?
    a. If the radio operator suspects jamming or enemy intrusion on the net, then the radio operator should report it immediately to higher headquarters. Such information is vital for the protection and defense of radio communications. Field meaconing, intrusion, jamming, and interference (MIJI) reports serve two purposes. First, initial MIJI reports facilitate battlefield evaluations of the enemy's actions or intentions and provide data for tactical countermeasures, as appropriate. Second, complete and accurate followup reports ensure MIJI incidents are documented and evaluated on a national level, thus providing data for a continuing study of foreign electronic warfare capabilities and activities.

202. How are MIJI reports transmitted?
    a. MIJI reports may be transmitted over nonsecure electronic means when secure communications are not available; however, the textual content of the MIJI report will be secured by an off-line (i.e., manual) system. Reports will be prepared in the format outlined in the following paragraphs. Brevity numbers pertinent to specific line item information are provided for some items. These brevity numbers must be encoded in the numeral cipher or authentication system prior to transmission.

203. What are the two type of MIJI reports?
    a. The two types of field MIJI reports are—
    b. MIJI 1—an abbreviated initial report containing only those items of information necessary to inform headquarters of the incident and enable them to initiate evaluatory or retaliatory actions as appropriate.
    c. MIJI 2—consists of 40 lines and is completed by higher headquarters.

204. What does the MIJI report include?
    a. Item 1—type report. When being transmitted over nonsecure communications means, the numerals 022 are encrypted as Item 1 of the MIJI 1 report. When

being transmitted over secure communications means, the term MIJI 1 is used as Item 1 of the MIJI 1 report. I Item 2—type MIJI incident. When being transmitted over nonsecure communications means, the appropriate numeral preceding one of the items below is encrypted as Item 2 of the MIJI 1 report. When being transmitted over secure communications means, the appropriate term below is used as Item 2 of the MIJI 1 report. 1 Meaconing 2 Intrusion 3 Jamming 4 Interference

b. Item 3—type of equipment affected. When being transmitted over nonsecure communications means, the appropriate numeral preceding one of the terms below is encrypted as Item 3 of the MIJI 1 report. When being transmitted over secure communications means, the appropriate term below is used as Item 3 of the MIJI 1 report. 1 Radio 2 Radar 3 Navigational aid 4 Satellite 5 Electro-optics I Item 4—Frequency or channel affected. When being transmitted over nonsecure communications means, the frequency or channel affected by the MIJI incident is encrypted as Item 4 of the MIJI 1 report. When being transmitted over secure communications means, the frequency or channel affected by the MIJI incident is Item 4 of the MIJI 1 report. I Item 5—victim designation and call sign of affected station operator. The complete call sign of the affected station operator is Item 5 of the MIJI 1 report over both secure and nonsecure communications means. I Item 6—coordinates of the affected station. When being transmitted over nonsecure communications means, the complete grid coordinates of the affected station are encrypted as Item 6 of the MIJI 1 report. When being transmitted over secure communications means, the complete grid coordinates of the affected station are Item 6 of the MIJI 1 report.

205. What is the MIJI 2 Report?

a. The MIJI 2 Report. This is a complete report containing all details of the MIJI incident. Due to the number of items which require encryption when the report is transmitted over a nonsecure circuit, it is recommended that the report be delivered by messenger whenever possible. The higher headquarters' operations officer, intelligence officer, or the electronic warfare officer is responsible for ensuring that a complete message report of the incident is submitted to the Joint Command and Control Warfare Center (JC2WC) within 24 hours of the incident.

206. What is a critical component of electronic protection?

a. Communications security (COMSEC) is an integral part of electronic protection. COMSEC is the protection resulting from all measures designed to deny unauthorized persons information of value that might be derived from the possession and study of telecommunications or to mislead unauthorized persons in their interpretation of the results of such possession and study. COMSEC includes transmission, cryptographic, emission, and physical security.

207. What is the goal of COMSEC?

a. The goal of COMSEC is to protect friendly communications from enemy exploitation while ensuring unimpeded use of the electromagnetic spectrum. The organization must be able to employ communications equipment effectively in the face of enemy efforts.

208. What is transmission security?

a. Transmission security (TRANSEC) is that component of COMSEC that results from all measures designed to protect transmissions from interception and exploitation by means other than cryptoanalysis. A message transmitted in the clear is the enemy's greatest source of information. After the enemy has intercepted your radio transmission, the enemy's language specialists will extract all possible intelligence from it. The enemy hopes to learn essential elements of friendly information (EEFI).

209. Critical information that must be protected can be remembered by the key words SELDOM UP. What does this refer to?

a. Each letter indicates a class of information as follows:
b. Strength—number of personnel, size of unit.
c. Equipment—type, quantity, condition.
d. Logistics—procedure for resupply, depots.
e. Disposition—were, what positions, map coordinates.
f. Organization—how, what, chain of command, forces structure.
g. Movement and morale—where, how, when and good or bad.
h. Units—type, designation.
i. Personalities—who, where.

210. How can radio operators maintain TRANSEC?

a. Using TRANSEC is absolutely essential for the radio operator.
b. When the radio must be used, keep transmission time to an absolute minimum (20 seconds absolute maximum: 15 seconds maximum preferred); preplan your messages to avoid compromising any essential element of information. If you must send EEFI items, use brevity lists, if possible, and also encrypt the message. These measures decrease your transmission, help prevent RDF, and deny the enemy valuable information. Included under transmission security are the authentication procedures that must be followed to protect against the enemy's IED. Every radio operator must be aware of the dangers of and guard against IED. Strict radio discipline and adherence to authorized procedures are key to ensuring TRANSEC over SCR networks. SINCGARS radios should be operated in a frequency hopping mode to provide maximum protection against enemy EW capabilities.

211. What may other TRANSEC measures include?

a. Well-trained operators thoroughly familiar with proper communications procedures and equipment operation. (This includes all Marines who may operate SCR, not just CIS personnel.) I Avoidance of unauthorized transmission and testing and maximum use of data networks to minimize transmission time and opportunity for enemy direction finding. I Use of transmitter, antenna, and power combinations that produce minimum wave propagation and emission intensity consistent with reliable communications.
b. Strict adherence to authorized frequencies. I Use of authentication systems to protect against imitative deception on nonsecure nets. I Use of changing call signs and frequencies on nonsecure nets. I Prompt response to and reporting of

enemy jamming. (Operators should continue to operate on assigned frequencies in a secure mode, unless otherwise directed by a competent authority, and should attempt to work through the interference.) I Strict adherence to all emission control (EMCON) restrictions and observance of radio silence. I Use of communications means that do not radiate in the electromagnetic spectrum such as messengers, visual and sound signaling, and local wire loops. I Use of terrain masking to shield transmission systems from enemy EW systems. I Remoting of transmitters and avoiding the clustering of antennas.

212. What is cryptosecurity?
   a. Cryptosecurity deals with codes, key lists, and communications security devices. This is the third line of defense for the radio operator. If the radio operator uses a security device on the radio, the enemy will not get anything for the language specialists to work on. However, do not get a false sense of security. The need for emission control and transmission security still exists—probably more so—because, if the enemy can't get information, the enemy might attempt to destroy or jam your station. Also, it is very important for all radio operators to use only authorized codes and to realize that using homemade codes is dangerous. Homemade codes offer no protection at all. Their use is not authorized and is a serious violation of security. This also includes trying to "talk around" a classified or sensitive piece of information. The enemy intelligence personnel are not fools, and trying something like "talking around" critical information does more harm than good. If critical information must be transmitted, it should be encrypted or sent by secure means. In a situation when it is not possible to send by a secure means or to encrypt a message that must be sent, the possibility of what friendly forces will lose against what the enemy could gain must be weighed. Other factors, such as how fast the enemy could react to the information and what delaying the message for encryption could mean, must also be considered.

213. What is emission security?
   a. Emission security (TEMPEST) is the component of COMSEC that results from all measures taken to deny unauthorized persons information of value that might be derived from interception and analysis of compromising emanations from cryptosecurity equipment and telecommunications systems. The operation of communications and information systems may result in unintentional electromagnetic emissions. Although tactical equipment is designed to reduce the possibility of such emissions, COTS equipment is not. Unintentional emissions are extremely susceptible to interception and analysis and may disclose classified information. Commanders must follow applicable regulations providing guidance on control and suppression of such emissions.

214. What is physical security?
   a. Physical security is the COMSEC component that results from all physical measures necessary to safeguard classified equipment, material, and documents from access or observation by unauthorized persons. The access to classified cryptographic information must be tightly controlled. When a commander or designated representative has determined that an individual has a need to know

and is eligible for access, then access to classified cryptographic information will be formally authorized. The authorization process must include an introduction to the unique nature of cryptographic information, its unusual sensitivity, the special security regulations governing its handling and protection, and the penalties prescribed for its disclosure.

215. What are reportable violations of COMSEC?
   a. Reportable violations include—
   b. Loss of material.
   c. Unauthorized viewing.
   d. Capture of individuals having access to COMSEC information.

216. When is COMSEC equipment unclassified for external viewing?
   a. Currently fielded COMSEC equipment is unclassified for external viewing when appropriate covers are in place and no keying material is visible. Consequently, the exposure of such equipment to casual viewing by uncleared personnel, whether by accident or as the result of operational necessity, does not constitute a reportable violation. EP techniques are divided into two categories: preventive and remedial. Preventive EP are those procedures that can be used to avoid enemy EA attempts. Remedial EP apply to jamming only; there are no remedial measures once a unit has been intercepted, detected, or deceived.

217. What does the enemy need to accomplish to intercept your radio signals?
   a. The enemy is focused on intercepting your radio signal. To do this, all the enemy needs is a radio receiver that operates in the same mode and on the same frequency you are using to transmit. The mere fact that you are operating gives the enemy valuable information. It tells the enemy that you are in the area. By the number of stations operating on the same frequency, the enemy can estimate the size of the unit. If your net is operating in the clear, the enemy's language specialists can understand exactly what is said for even more information. When analyzing the traffic pattern, the enemy can figure out which station is the net control station (NCS) and identify the headquarters. Usually, in U.S. forces, the NCS is the radio used by the operations officer or section of the highest headquarters operating in the net. By further traffic analysis, the enemy can determine changes in the level of activity that could mean a movement or upcoming operation.

218. What are some of the dangers the radio operator may face in combat?
   a. Interception is only one of the many dangers that the radio operator will face. After knowing friendly forces are in the area, the enemy will try to locate their position by using radio direction finding (RDF). A radio direction finder consists of a radio receiver, a directional antenna, and other specialized equipment. With RDF equipment, the approximate azimuth (i.e., bearing) to a transmitting radio can be determined. One azimuth gives a general indication of direction. The intersection of two azimuths by different RDF stations is called a cut and gives a general indication of distance. The intersection of three or more azimuths is called a fix and gives a general location. The ideal fix is the exact intersection of three or more bearings. However, exact intersection is seldom achieved.

219. What prevents an ideal fix?

a. Terrain, weather, variations in radio wave propagation characteristics, the inherent RDF equipment, and operator inaccuracies, prevent an ideal fix. The fix that is obtained is called an actual fix. Although the actual fix may not be usable for immediate targeting purposes, it is more than enough for intelligence analysts to develop targeting data. Airborne direction finding is more accurate than ground-based direction finding but normally requires further analysis for targeting.

220. How are field coordinates expressed?

a. Field coordinates are often expressed in universal transverse mercator grid coordinates and usually consist of 6-digit numbers. The typical map used by the radio operator is a 1 to 50,000 scale topographic map that has grid lines drawn on it, which are 1,000 meters (1 kilometer or klick) apart.

221. How is the world divided? How does this impact time measurement?

a. The world is divided into 24 time zones, each one bearing a unique phonetic letter name (ROMEO, UNIFORM, etc.) or time zone number that must be applied to local time to arrive at the world standard time which is Coordinated Universal Time (UTC). This standard time is referred to in the Marine Corps as ZULU time. (See fig. B-1.) The time zones are roughly 15° apart in longitude.

222. What is the formula for zulu time?

a. ZULU TIME = LOCAL TIME - TIME ZONE NUMBER.

223. What is the formula for local time?

a. LOCAL TIME = ZULU TIME + TIME ZONE NUMBER.

224. How should times be states during operations?

a. AUTODIN communications (i.e., worldwide) ZULU time should be used in all messages. Within the operational area, however, local time is usually used. To avoid confusion, the time zone should always be stated e.g., 1100 LOCAL or 1900 ZULU.

225. When should challenge and reply authentication be used?

a. Challenge and reply authentication will be used whenever possible. The called party will always make the first challenge. Besides validating the authenticity of the calling station, this practice prevents an enemy operator from entering a net to obtain correct authentication responses for use in another net. The party making the call may counterchallenge the called party using a different challenge.

226. What actions are taken when a station suspects imitative deception?

a. When any station suspects imitative deception on any circuit; e.g.,
b. when contacting a station following one or more unsuccessful
c. attempts to contact that station.
d. When any station is challenged or requested to authenticate. This is
e. not to be interpreted as requiring stations to break an imposed silence
f. for the sole purpose of authenticating.
g. When directing radio silence, listening silence, or requiring a station
h. to break an imposed silence.
i. When transmitting contact and amplifying reports in plain language.

j. When transmitting operating instructions that affect the military situation; e.g., closing down a station or watch, changing frequency other
k. than normal scheduled changes, directing establishment of a special
l. communication guard, requesting artillery fire support, directing relocation of units, etc.
m. When transmitting a plain language cancellation.
n. When making initial radio contact or resuming contact after prolonged interruptions.
o. When transmitting to a station that is under radio listening silence.
p. When authorized to transmit a classified message in the clear.
q. When forced, because of no response by the called station to send a
r. message in the blind (transmission authentication).

227. What can you do when a whip antenna is broken into two sections?

a. When a whip antenna is broken into two sections, the portion of the antenna that is broken off can be connected to the portion attached to the base by joining the sections as shown in figure O-1 on page O-2. Use the method illustrated in figure O-1A, when both parts of the broken whip are available and usable. Use the method shown in figure O-1B when the portion of the whip that was broken off is lost, or when the whip is badly damaged. To restore the antenna to its original length, add a piece of wire that is nearly the same length as the missing part of the whip. Then, lash the pole support securely to both sections of the antenna. Clean the two antenna sections thoroughly to ensure good contact before connecting them to the pole support. If possible, solder the connections.

228. What may repair of a wire antenna involve?

a. Emergency repair of a wire antenna may involve the repair or replacement of the wire used as the antenna or transmission line; or, the repair or replacement of the assembly used to support the antenna.
b. When one or more wires of an antenna are broken, the antenna can be repaired by reconnecting the broken wires. To do this, lower the antenna to the ground, clean the ends of the wires, and twist the wires together. Whenever possible, solder the connection. If the antenna is damaged beyond repair, construct a new one. Make sure that the lengths of the wires of the substitute antenna are the same length as the original.

229. How are antenna supports be repaired or replaced?

a. Antenna supports may also require repair or replacement. A substitute item may be used in place of a damaged support and, if properly insulated, can be of any material of adequate strength. If the radiating element is not properly insulated, field antennas may be shorted to ground and rendered ineffective. Many commonly found items can be used as field expedient insulators. The best of these items are plastic or glass, to include plastic spoons, buttons, bottle necks, and plastic bags. Less effective than plastic or glass but better than no insulators at all are wood and rope, or both, in that order. The radiating element—the actual antenna wire—should touch only the antenna terminal and be physically separated from all other objects, other than the supporting insulator. Figure O-2 shows various emergency insulators.

230. What are used to stabilize supports for an antenna?
    a. Lines used to stabilize the supports for an antenna are called guys. These lines are usually made of wire, manila rope, or nylon rope. If a rope breaks, it may be repaired by tying the two broken ends together. If the rope is too short after the tie is made, it can be lengthened by adding another piece of dry wood or cloth. If a guy wire breaks, it can be replaced with another piece of wire. Figure O-3 shows a method of repairing a guy line with a spoon.

231. What can be used as replacements for radio masts?
    a. Some antennas are supported by masts. If a mast breaks, it can be replaced with one of same length. If long poles are not available as replacements, short poles may be overlapped and lashed together with rope or wire to provide a pole of the required length. Figure O-3 shows a method of making an emergency repair to masts.

232. What are the best types of antennas used for antennas?
    a. The best kinds of wire for antennas are copper and aluminum. In an emergency, however, use any type that is available. The length of most antennas is critical. The emergency antenna should be the same length as the antenna it replaces. Antennas supported by trees can usually survive heavy wind storms if the trunk of a tree or a strong branch is used as a support. To keep the antenna taut and to prevent it from breaking or stretching as the trees sway, attach a spring or old inner tube to one end of the antenna. Another technique is to pass a rope through a pulley or eyehook, attach the rope to the end of the antenna, and load the rope with a heavy weight to keep the antenna tightly drawn. Guys used to hold antenna supports are made of rope or wire. To ensure that the guys made of wire will not affect the operation of the antenna, cut the wire into several short lengths and connect the pieces with insulators.

233. How can you determine if an improvised antenna is operating properly?
    a. An improvised antenna may change the performance of a radio set. Use the following methods to determine if the antenna is operating properly. A distant station may be used to test the antenna. If the signal received from this station is strong, the antenna is operating satisfactorily. If the signal is weak, adjust the height and length of the antenna and the transmission line to receive the strongest signal at a given setting on the volume control of the receiver. This is the best method of tuning an antenna when transmission is dangerous or forbidden. In some radio sets, the transmitter is used to adjust the antenna. First, set the controls of the transmitter in the proper position for normal operation; then, tune the system by adjusting the antenna height, the antenna length, and the transmission line length to obtain the best transmission output. Impedance-matching a load to its source is an important consideration in transmissions' systems. If the load and source are mismatched, part of the power is reflected back along the transmission line towards the source. This reflection not only prevents maximum power transfer, but can also be responsible for

erroneous measurements of other parameters, or even cause circuit damage in high-power applications. The power reflected from the load interferes with the incident (i.e., forward) power, causing standing waves of voltages and current to exist along the line. The ratio of standing-wave maxima to minima is directly related to the impedance mismatch of the load; therefore the standingwave ratio (SWR) provides the means of determining impedance and mismatch.

234. What are the primary methods of communications for Marine Corps forces around the world?

   a. SINCGARS VHF radios provide the primary means of communications for Marine Corps forces around the world. The SINCGARS radio operates in both single-channel and frequency hopping modes. It is important for CIS personnel to remember that when using the SINCGARS radio in the frequency hopping mode, field expedient VHF antennas should not be used. CIS personnel should only use the whip antenna or the OE-254 antenna when operating in the frequency hopping mode.

235. How can vertical antennas be improvised?

   a. Vertical antennas are omnidirectional; i.e., they transmit and receive equally well in all directions. Most manpack portable radios use a vertical whip antenna. A vertical antenna can be improvised by using a metal pipe or rod of the correct length, held erect by means of guys. The lower end of the antenna should be insulated from the ground by placing it on insulating material. A vertical antenna may also be a wire, supported by a tree or a wooden pole (see fig. O-4). For short, vertical antennas, the pole may be used without guys (if properly supported at the base). If the length of the vertical mast is not long enough to support the wire upright, it may be necessary to modify the connection at the top of the antenna.

236. How can end-fed half-wave antennas be constructed?

   a. An emergency, end-fed half-wave antenna can be constructed from available materials such as field wire, rope, and wooden insulators. The electrical length of this antenna is measured from the antenna terminal on the radio set to the far end of the antenna (see fig. O-5). Construct the antenna longer than necessary, then shorten it, as required, until best results are obtained. The ground terminal of the radio set should be connected to a good Earth ground for this antenna to function efficiently

237. What is the center-fed doublet?

   a. The center-fed doublet is a half-wave antenna consisting of two, quarterwavelength sections on each side of the center. Construction of an improvised doublet antenna for use with FM radios is shown in figure O-6. Doublet antennas are directional broadside to their length, which makes the vertical doublet antenna essentially omnidirectional. This is because the radiation pattern is doughnut shaped. The horizontal doublet antenna is bidirectional. The length of a half-wave antenna may be computed by using the formula in Chapter 4. Cut the wires as closely as possible to the correct length because the length of the antenna wires is important.

238. What is a transmission line used for?

a. A transmission line is used for conducting electrical energy from one point to another, and it is used to transfer the output of a transmitter to an antenna. Although it is possible to connect an antenna directly to a transmitter, the antenna generally is located some distance away. In a vehicular installation, for example, the antenna is mounted outside, and the transmitter is inside the vehicle. A transmission line, therefore, is necessary as a connecting link.

239. How can center fed half wave FM antennas be supported?

a. Center-fed half-wave FM antennas can be supported entirely by pieces of wood. A horizontal antenna of this type is shown in figure O-7A; a vertical antenna in figure O-7B on page O-10. These antennas can be rotated to any position to obtain the best performance. If the antenna is erected vertically, the transmission line should be brought out horizontally from the antenna for a distance equal to at least one-half of the antenna's length before it is dropped down to the radio set.

240. What are the characteristics of the vertical half-rhomic antenna and long wire antenna?

a. The vertical half-rhombic antenna (fig. O-10 on page O-12) and the long-wire antenna (fig. O-11 on page O-12) are two field expedient,directional antennas. These antennas consist of a single wire, preferably two or more wavelengths long, supported on poles at a height of 3 to 7 meters (10 to 20 feet) above the ground. The antennas will, however, operate satisfactorily as low as 1 meter (approximately 3 feet) above the ground. The far end of the wire is connected to ground through a noninductive resistor of 500 to 600 ohms. Use a resistor rated at least one-half the wattage output of the transmitter to ensure the resistor is not burned out by the output power of the transmitter. A reasonably good ground, such as a number of ground rods or a counterpoise, should be used at both ends of the antenna. The radiation pattern is directional. The antennas are used primarily for either transmitting or receiving high frequency signals.

241. How can you make a Vee antenna?

a. The Vee antenna is another field expedient, directional antenna. It consists of two wires forming a Vee with the open area of the Vee pointing toward the desired direction of transmission or reception (see fig. O-12). To make construction easier, the legs may slope downward from the apex of the Vee (this is called a sloping Vee antenna [see fig. O-13 on page O-14]). The angle between the legs varies with the length of the legs in order to achieve maximum performance. When the antenna is used with more than one frequency or wavelength, use an apex angle that is midway between the extreme angles determined by the chart. To make the antenna radiate in only one direction, add noninductive terminating resistors from the end of each leg (not at the apex) to ground.

242. What steps may be required in operating a radio set?

a. Radio sets issued to a unit vary in type according to the communications requirements of the unit. For example, some sets may be completely contained in one assembly, while others may consist of separate components that must be properly connected to assemble a complete radio set. The following steps are generally required in operating a radio set.

b. Check the Set for Completeness Make sure that all the necessary components and accessories are on hand and ready for use. Refer to the equipment basic issue items list in the TM. Never operate the transmitter without the antenna attached. Inspect the Condition of the Knobs, Dials, Switches, and Controls Look for knobs, dials, switches, and controls that are loose on their shafts, bind when being operated, won't operate, or are damaged in any other way. Make corrections where possible or report the faulty condition to the CIS officer or CIS chief. Make sure that all knobs and exterior parts are on the set. Immediately report any that are missing. Check the Condition of Plugs, Receptacles, and Connectors Do not attempt to connect the set for operation until you are sure that the plugs and connectors are clean and in good condition, and the receptacles to which they must be connected are also clean and in good condition. Check the Connections Diagrams The connections diagrams in the equipment TM show the type and number of cables required to interconnect the components of the radio set for each type of operation. The radio set may be damaged if cables are connected to the wrong receptacles. If the connectors don't match, it is possible to physically damage the pins or sleeves of the connector. If a cable is connected to a receptacle into which it fits but does not belong, it may cause serious electrical damage to the equipment and, in some cases, injury to the operator. Make Sure of Dial, Switch, and Control Settings Some radio sets can be seriously damaged if the switches, dials, and controls are not set to the required initial settings before applying power or making the initial timing adjustments. Before applying power, check the equipment TM to be sure you performed all preliminary starting procedures. Be sure radios installed in vehicles are turned off before starting the vehicle's engine to avoid damage to radio equipment. Follow the Starting Procedure The equipment TM covers, in detail, the proper procedure for starting the radio set. If there is a specific sequence for starting the set, it is described in the manual. Perform the operations in the proper sequence. Apply Power After the proper connections are made, and all switches are properly set, power may be applied to the set. Allow the Set to Warm Up Radio sets usually require a warm-up period when first applying power in order to stabilize the equipment. In some cases, it is possible to damage a set by attempting to operate a set without allowing a warm-up period. Most sets are protected against such damage, but it is foolish to risk damage to a radio set by trying to put it on the air before it is ready. Tune to the Desired Frequency (Channel) Tune the transmitter to the frequency of the desired channel according to the procedures in the equipment TM. Use the methods that are given in the TM to check for correct tuning. Check the Set for Normal Operation While the set is in operation, check the indicators frequently to be sure that the set is operating correctly. If anything unusual occurs during operation, investigate it immediately. When necessary, turn off the power to the set and refer to the operational checklist and the equipment performance checklist in the equipment manual. If the corrections given in the operational checklist and the equipment performance checklist will not correct the trouble, report the condition to the unit electronics maintenance shop. Make sure that the condition of the set and the action taken are properly recorded on the maintenance records. Use the Proper Procedure to Turn Off the Set After operation (or if the set is being turned off because of improper operation) make sure that the controls, switches, and dials are properly set (this may not be required on some radios). Proceed to shut down the components of the set in the sequence specified in the equipment manual. Simple radios may require nothing more than turning the power switch to its OFF position, but more complex sets may require elaborate shutdown procedures.

243. What may cause lack of communication or poor communcations?

a. Lack of communications or poor communications may be caused by—
b. Too great a distance between radio sets.
c. Poor choice of location (siting) at one or both ends of the circuit.
d. Terrain—hills or mountains.
e. Noise and interference.
f. Not enough transmitter power.
g. Defective equipment.
h. Improper adjustment of equipment.
i. Ineffective antenna.
j. Improper frequency assignment.

244. Why is equipment maintenance so important? What can you to to ensure maintenance of communication equipment?

a. Poorly maintained equipment and improper operation can be just as effective in preventing communications as excessive distance or mountainous terrain. To avoid problems, observe the following precautions at all times:
b. Study the TMs for the equipment you are using. They provide complete operating instructions and maintenance procedures.
c. Keep your radio set clean and dry.
d. Handle your radio set carefully.