1. What is a map?
   a. graphic representation of a portion of the earth's surface drawn to scale, as seen from above. It uses colors, symbols, and labels to represent features found on the ground.
2. The ideal representation of a map would be represented if:
   a. every feature of the area being mapped could be shown in true shape.
3. An attempt to plot each feature true-to-scale would result in what occurring?
   a. A product impossible to read even with the aid of a magnifying glass.
4. To be understandable, features on a map must be represented by what?
   a. Conventional signs and symbols.
5. On a 1:250,000-scale map, the prescribed symbol for a building covers an area about:
   a. 500 square feet on the ground.
6. On a 1:250,000-scale map, a road symbol is equivalent to a road about:
   a. 520 feet wide on the ground.
7. The symbol for a single-track railroad (the length of a cross-tie) is equivalent to a railroad cross-tie about:
   a. 1,000 feet on the ground.
8. A map provides information on the existence of, the location of, and the distance between ground features such as:
   a. populated places and routes of travel and communication. It also indicates variations in terrain, heights of natural features, and the extent of vegetation cover. With our military forces dispersed throughout the world, it is necessary to rely on maps to provide information to our combat elements and to resolve logistical operations far from our shores.
9. Maps are documents printed on paper. What do they require for prolonged use?
   a. Protection from water, mud, and tearing.
10. Whenever possible, how should a map be carried?
    a. Waterproof case, in a pocket, or in some other place where it is handy for use but still protected.
11. Because a map is a graphic representation of a portion of the earth's surface drawn to scale as seen from above, it is important to know what mathematical scale has been used. Why do you need to know the mathematical scale?
    a. You must know the scale to determine ground distances between objects or locations on the map, the size of the area covered, and how the scale may affect the amount of detail being shown.
12. NGA maps are classified by scale into three categories. What are they?
    a. small, medium, and large-scale maps
13. What are the characteristics of small scale maps?
    a. Maps with scales of 1:1,000,000 and smaller are used for general planning and for strategic studies (bottom map in Figure 2-1). The standard small-scale map is 1:1,000,000. This map covers a very large land area at the expense of detail.
14. What is the map of choice for land navigation?
    a. 1:50,000-scale military topographic map.

15. What are the characteristics of medium scale maps?
    a. Maps with scales larger than 1:1,000,000 but smaller than 1:75,000 are used for operational planning (center map in Figure 2-1). They contain a moderate amount of detail, but terrain analysis is best done with the large-scale maps. The standard medium-scale map is 1:250,000. Medium-scale maps of 1:100,000 are also frequently encountered.
16. What are the characteristics of large scale maps?
    a. Maps with scales of 1:75,000 and larger are used for tactical, administrative, and logistical planning (top map in Figure 2-1). These are the maps that you as a Soldier or junior leader are most likely to encounter. The standard large-scale map is 1:50,000; however, many areas have been mapped at a scale of 1:25,000.
17. What is a planimetric map?
    a. A planimetric map presents only the horizontal positions for the features represented. It is distinguished from a topographic map by the omission of relief, normally represented by contour lines. Sometimes, it is called a line map.
18. What are the characteristics of a topographic map?
    a. A topographic map portrays terrain features in a measurable way, as well as the horizontal positions of the features represented. The vertical positions, or relief, are normally represented by contour lines on military topographic maps. On maps showing relief, the elevations and contours are measured from a specific vertical datum plane, usually mean sea level. (Figure 3-1 in Chapter 3 shows a typical topographic map.)
19. What is a photomap?
    a. A photomap is a reproduction of an aerial photograph upon which grid lines, marginal data, place names, route numbers, important elevations, boundaries, and approximate scale and direction have been added. (See Chapter 8 for additional information on aerial photographs.)
20. What are Joint Operations Graphics?
    a. Joint operations graphics are based on the format of standard 1:250,000 medium-scale military topographic maps, but they contain additional information needed in joint air-ground operations (Figure 2-2). Along the north and east edges of the graphic, detail is extended beyond the standard map sheet to provide overlap with adjacent sheets. These maps are produced both in ground and air formats.
21. What are photomosaics?
    a. A photomosaic is an assembly of aerial photographs that is commonly called a mosaic in topographic usage. Mosaics are useful when time does not permit the compilation of a more accurate map. The accuracy of a mosaic depends on the method employed in its preparation and may vary from simply a good pictorial effect of the ground to that of a planimetric map.
22. What is a terrain model? What is a terrain model used for?
    a. A terrain model is a scale model of the terrain showing features, and in large-scale models showing industrial and cultural shapes. It provides a means

for visualizing the terrain for planning or indoctrination purposes and for briefing on assault landings.

23. What is a military city map?
    a. A military city map is a topographic map (usually at 1:12,550 scale, sometimes up to 1:5,000), showing the details of a city. It delineates streets and shows street names, important buildings, and other elements of the urban landscape important to navigation and military operations in urban terrain. The scale of a military city map depends on the importance and size of the city, density of detail, and available intelligence information.
24. What are special maps?
    a. Special maps are for special purposes such as trafficability, communications, and assault maps. They are usually in the form of an overprint in the scales smaller than 1:100,000 but larger than 1:1,000,000. A special purpose map is one that has been designed or modified to give information not covered on a standard map.
25. The wide range of subjects that could be covered under the heading of special purpose maps prohibits, within the scope of this manual, more than a brief mention of a few important ones. Some of the subjects covered are?
    a. • Terrain features.
    b. • Drainage characteristics.
    c. • Vegetation.
    d. • Climate.
    e. • Coasts and landing beaches.
    f. • Roads and bridges.
    g. • Railroads.
    h. • Airfields.
    i. • Urban areas.
    j. • Electric power.
    k. • Fuels.
    l. • Surface water resources.
    m. • Ground water resources.
    n. • Natural construction materials.
    o. • Cross-country movements.
    p. • Suitability for airfield construction.
    q. • Airborne operations.
26. What are foreign maps?
    a. Foreign maps have been compiled by nations other than our own. When they must be used, the marginal information and grids are changed to conform to our standards, if time permits. The scales may differ from our maps, but they do express the ratio of map distance to ground distance and can be used in the same way.
27. What are atlases?

    a. Atlases are collections of maps of regions, countries, continents, or the world. Such maps are accurate only to a degree and can be used for general information only.

28. What are geographic maps?
    a. Geographic maps provide an overall idea of the mapped area in relation to climate, population, relief, vegetation, and hydrography. They also show the general location of major urban areas.
29. What are Tourist Road Maps?
    a. Tourist road maps are maps of a region in which the main means of transportation and areas of interest are shown. Some of these maps show secondary networks of roads, historic sites, museums, and beaches in detail. They may contain road and time distance between points. The scale should be carefully considered when using these maps.
30. What are city/utility maps?
    a. City/utility maps are maps of urban areas showing streets, water ducts, electricity and telephone lines, and sewers.
31. What are Field Sketches?
    a. Field sketches are preliminary drawings of an area or piece of terrain.
32. What are Aerial Photographs?
    a. Aerial photographs can be used as map supplements or substitutes to help you analyze the terrain, plan your route, or guide your movement.
33. What is the definition of map accuracy?
    a. degree of conformity with which horizontal positions and vertical values are represented on a map in relation to an established standard. This standard is determined by the NGA based on user requirements. Maps are considered to meet accuracy requirement standards unless otherwise specified in the marginal information.
34. Where can the sheet name be found?
    a. Found in bold print at center top, lower left of map. Generally named for largest settlement in area or Largest natural feature
35. What is the sheet number used for?
    a. Used as reference number to link specific maps to overlays, opords
36. Where can the scale be found on a map?
    a. Found in upper left after series name Scale note is a representative fraction that is the ratio of map distance in relation to distance on the ground
37. What is a maps series number?
    a. Sequence reference measured as 4 digit numeral or as a letter followed by a numeral
38. What items are used in Terrain association?
    a. Terrain features
    b. Elevation changes
    c. Man made features
    d. These features determine ground movement and ground positions

39. Whet is the process for Point navigation?
    a. Start from known point, follow azimuth and distance
    b. Needs high degree of control and slight deviation can cause navigation errors
40. What are considerations when using a Combination of navigation methods?
    a. Speedy but tough
    b. Understand when to use each method
41. What are handrails?
    a. Linear features like roads, rigelines, streams parallel to direction of travel
42. What are catching features?
    a. Roads/rivers location near objective; beginning point
43. Where can the Index to Boundaries be found? What is it used for?
    a. The index to boundaries diagram appears in the lower or right margin of all sheets. This diagram, which is a miniature of the map, shows the boundaries that occur within the map area such as county lines and state boundaries.
44. What is an Adjoining Sheets Diagram? What is it used for?
    a. Maps at all standard scales contain a diagram thatillustrates the adjoining sheets. On maps at 1:100,000 and larger scales and at 1:1,000,000 scale, the diagram is called the index to adjoining sheets. It consists of as many rectangles representing adjoining sheets as are necessary to surround the rectangle that represents the sheet under consideration. The diagram usually contains nine rectangles, but the number may vary depending on the locations of the adjoining sheets. All represented sheets are identified by their sheet numbers. Sheets of an adjoining series, whether published or planned, that are at the same scale are represented by dashed lines. The series number of the adjoining series is indicated along the appropriate side of the division line between the series.
45. Where is the Elevation Guide found? What is it used for?
    a. The elevation guide is normally found in the lower rightmargin. It is a miniature characterization of the terrain shown. The terrain is represented by bands of elevation, spot elevations, and major drainage features. The elevation guide provides the map reader with a means of quick recognition of major landforms.
46. What is the Declination Diagram? What is it used for?
    a. The declination diagram is located in the lower margin of large-scale maps and indicates the angular relationships of true north, grid north, and magnetic north. On maps at 1:250,000 scale, this information is expressed as a note in the lower margin. In recent edition maps, there is a note indicating the conversion of azimuths from grid to magnetic and from magnetic to grid next to the declination diagram.
47. What are Bar Scales? What are they used for?
    a. Bar scales are located in the center of the lower margin. They are rulers used to convert map distance to ground distance. Maps have three or more bar scales, each in a different unit of measure. Care should be exercised when using the scales, especially in the selection of the unit of measure that is needed.

48. Where can the Contour Interval Note be found? What is it used for?
    a. The contour interval note is found in the center of the lower margin normally below the bar scales. It states the vertical distance between adjacent contour lines of the map. When supplementary contours are used, the interval is indicated. In recent edition maps, the contour interval is given in meters instead of feet.
49. Where can the Spheroid Note be found?
    a. The spheroid note is located in the center of the lower margin. Spheriods (ellipsoids) have specific parameters that define the X Y Z axis of the earth. The spheriod is an integral part of the datum.
50. Where can the grid note be located? What is it used for?
    a. The grid note is located in the center of the lower margin. It gives information pertaining to the grid system used and the interval between grid lines, and it identifies the UTM grid zone number.
51. What is the Projection Note? Where can it be found? What is it used for?
    a. The projection system is the framework of the map. For military maps, this framework is of the conformal type; that is, small areas of the surface of the earth retain their true shapes on the projection; measured angles closely approximate true values; and the scale factor is the same in all directions from a point. The projection note is located in the center of the lower margin.
52. Where can the Vertical Datum Note be located? What is it?
    a. The vertical datum note is located in the center of the lower margin. The vertical datum or vertical-control datum is defined as any level surface taken as a surface of reference from which to determine elevations. In the United States, Canada, and Europe, the vertical datum refers to the mean sea level surface. However, in parts of Asia and Africa, the vertical-control datum may vary locally and is based on an assumed elevation that has no connection to any sea level surface. Map readers should habitually check the vertical datum note on maps, particularly if the map is used for low- level aircraft navigation, naval gunfire support, or missile target acquisition.
53. Where can the Horizontal Datum Note be located? What is it?
    a. The horizontal datum note is located in the center of the lower margin. The horizontal datum or horizontal-control datum is defined as a geodetic reference point (of which five quantities are known: latitude, longitude, azimuth of a line from this point, and two constants, which are the parameters of reference ellipsoid).
54. Where can the Control Note be located? What does it indicate?
    a. The control note is located in the center of the lower margin. It indicates the special agencies involved in the control of the technical aspects of all the information that is disseminated on the map.
55. What is the Preparation Note? Where can it be found?
    a. The preparation note is located in the center of the lower margin. It indicates the agency responsible for preparing the map.

56. What is the Printing Note? Where can it be found?
    a. The printing note is also located in the center of the lower margin. It indicates the agency responsible for printing the map and the date the map was printed. The printing data should not be used to determine when the map information was obtained.
57. What is the Grid Reference Box? Where can it be found?
    a. The grid reference box is normally located in the center of the lower margin. It contains instructions for composing a grid reference.
58. What is the Unit Imprint and Symbol? Why is it important to the map user?
    a. The unit imprint and symbol is on the left side of the lower margin. It identifies the agency that prepared and printed the map with its respective symbol. This information is important to the map user in evaluating the reliability of the map.
59. What is the map Legend? What is it used for?
    a. The legend is located in the lower left margin. It illustrates and identifies the topographic symbols used to depict some of the more prominent features on the map. The symbols are not always the same on every map. Always refer to the legend to avoid errors when reading a map.
60. What is the Glossary? What is it used for?
    a. The glossary is an explanation of technical terms or a translation of terms on maps of foreign areas where the native language is other than English.
61. Where can the map Classification be found?
    a. Certain maps require a note indicating the security classification. This is shown in the upper and lower margins.
62. Where is the Protractor Scale and what is it used for?
    a. The protractor scale may appear in the upper margin on some maps. It is used to lay out the magnetic-grid declination for the map, which, in turn, is used to orient the map sheet with the aid of the lensatic compass.
63. What is a Coverage Diagram and what is it used for?
    a. On maps at scales of 1:100,000 and larger, a coverage diagram may be used. It is normally in the lower or right margin and indicates the methods by which the map was made, dates of photography, and reliability of the sources. On maps at 1:250,000 scale, the coverage diagram is replaced by a reliability diagram.
64. What are Special Notes and what are they used for?
    a. A special note is any statement of general information that relates to the mapped area. It is normally found in the lower right margin. For example: This map is red-light readable.
65. What are User's Notes?
    a. The user's note is normally located in the lower right-hand margin. It requests cooperation in correcting errors or omissions on the map. Errors should be marked and the map forwarded to the agency identified in the note.
66. What is the Stock Number Identification used for?
    a. All maps published by the NGA that are in the Department of the Army map supply system contain stock number identifications that are used in requisitioning map supplies.

67. Where can the Conversion Graph be found and what is it used for?
    a. Normally found in the right margin, the conversion graph indicates the conversion of different units of measure used on the map.
68. What at military symbols used for?
    a. In addition to the topographic symbols used to represent the natural and man-made features of the earth, military personnel require some method for showing identity, size, location, or movement of Soldiers, and military activities and installations. The symbols used to represent these military features are known as military symbols. These symbols are not normally printed on maps because the features and units they represent are constantly moving or changing; military security is also a consideration.
69. By the fifteenth century, most European maps were carefully colored. What other features were present on these maps?
    a. Profile drawings of mountains and hills were shown in brown, rivers and lakes in blue, vegetation in green, roads in yellow, and special information in red. A look at the legend of a modern map confirms that the use of colors has not changed much over the past several hundred years.
70. To facilitate the identification of features on a map, the topographical and cultural information is usually printed in different colors. Are these colors consistent on all maps?
    a. No. These colors may vary from map to map.
71. What does black indicate on a map?
    a. Black indicates cultural (man-made) features such as buildings and roads, surveyed spot elevations, and all labels.
72. What does the dolor red-brown indicate on a map?
    a. The colors red and brown are combined to identify cultural features, all relief features, nonsurveyed spot elevations, and elevation such as contour lines on red-light readable maps.
73. What does the color blue indicate on a map?
    a. Blue identifies hydrography or water features such as lakes, swamps, rivers, and drainage.
74. What does the color Green indicate on a map?
    a. Green identifies vegetation with military significance such as woods, orchards, and vineyards.
75. What does the color brown indicate on a map?
    a. Brown identifies all relief features and elevation such as contours on older edition maps and cultivated land on red-light readable maps.
76. What does the color red typically indicate on a map?
    a. Red classifies cultural features, such as populated areas, main roads, and boundaries, on older maps.
77. Do maps use other colors as well?
    a. Occasionally, other colors may be used to show special information. These are indicated in the marginal information as a rule.

78. In a city, it is quite simple to find a location; the streets are named and the buildings have numbers. In comparison, how difficult can it be to find a location in an undeveloped area?
    a. The only thing needed is the address. However, finding locations in undeveloped areas or in unfamiliar parts of the world can be a problem. To cope with this problem, a uniform and precise system of referencing has been developed.
79. The distance of a point north or south of the equator is known as its latitude. What are the rings parallel to the equator called? What directions to these lines run?
    a. The rings around the earth parallel to the equator are called parallels of latitude or simply parallels. Lines of latitude run east-west but north-south distances are measured between them.
80. A second set of rings around the globe at right angles to lines of latitude and passing through the poles are known as what?
    a. meridians of longitude or simply meridians. One meridian is designated as the prime meridian. The prime meridian of the system we use runs through Greenwich, England and is known as the Greenwich meridian. The distance east or west of a prime meridian to a point is known as its longitude. Lines of longitude (meridians) run north-south but east-west distances are measured between them
81. Geographic coordinates are expressed in angular measurement. What are representations of these angles?
    a. Each circle is divided into 360 degrees, each degree into 60 minutes, and each minute into 60 seconds. The degree is symbolized by °, the minute by ′, and the second by ″.
82. Starting with 0° at the equator, the parallels of latitude are numbered to 90° both north and south. Where are the extremities located? Why is the indication of N or S important?
    a. The extremities are the north pole at 90° north latitude and the south pole at 90° south latitude. Latitude can have the same numerical value north or south of the equator, so the direction N or S must always be given.
83. Starting with 0° at the prime meridian, longitude is measured both east and west around the world. How are lines of longitude measured?
    a. Lines east of the prime meridian are numbered to 180° and identified as east longitude; lines west of the prime meridian are numbered to 180° and identified as west longitude. The direction E or W must always be given. The line directly opposite the prime meridian, 180°, may be referred to as either east or west longitude.
84. The values of geographic coordinates, being in units of angular measure, will mean more if they are compared with more familiar units of measure. What is one degree of latitude equivalent to?
    a. At any point on the earth, the ground distance covered by one degree of latitude is about 111 kilometers (69 miles); one second is equal to about 30 meters (100 feet). The ground distance covered by one degree of longitude at the equator is also about 111 kilometers, but decreases as one moves north or south, until it becomes zero at the poles. For example, one second of longitude represents about 30 meters (100 feet) at the equator; but at the latitude of Washington, DC,

    one second of longitude is about 24 meters (78 feet). Latitude and longitude are illustrated in Figure 4-3.

85. Geographic coordinates appear on all standard military maps; on some they may be the only method of locating and referencing the location of a point. How are latitude and longitude lines represented on a map?
    a. The four lines that enclose the body of the map (neatlines) are latitude and longitude lines. Their values are given in degrees and minutes at each of the four corners. In addition to the latitude and longitude given for the four corners, there are small tick marks at regularly spaced intervals along the sides of the map, extending into the body of the map. Each of these tick marks is identified by its latitude or longitude value.
86. An examination of the transverse Mercator projection, which is used for large-scale military maps, shows that most lines of latitude and longitude are curved lines. How does this impact your ability to find points on these maps?
    a. The quadrangles formed by the intersection of these curved parallels and meridians are of different sizes and shapes, complicating the location of points and the measurement of directions. To aid these essential operations, a rectangular grid is superimposed upon the projection. This grid (a series of straight lines intersecting at right angles) furnishes the map reader with a system of squares similar to the block system of most city streets.
87. The dimensions and orientation of different types of grids vary, but three properties are common to all military grid systems. What are they?
    a. one, they are true rectangular grids; two, they are superimposed on the geographic projection; and three, they permit linear and angular measurements.
88. What is the Universal Transverse Mercator (UTM) Grid? What is it used for?
    a. The UTM grid system was adopted by the U.S. Army in 1947 for designating rectangular coordinates on large-scale military maps. The UTM is currently used by the United States and NATO armed forces. With the advent of inexpensive GPS receivers, many other map users are adopting the UTM grid system for coordinates that are simpler to use than latitude and longitude.
89. What was the UTM grid designed for?
    a. The UTM grid was designed to cover that part of the world between latitude 84°N and latitude 80°S, and, as its name implies, is imposed on the transverse Mercator projection. Each of the 60 zones (6 degrees wide) into which the globe is divided for the grid has its own origin at the intersection of its central meridian and the equator (Figure 4-8). The grid is identical in all 60 zones. Base values (in meters) are assigned to the central meridian and the equator, and the grid lines are drawn at regular intervals parallel to these two base lines.
90. With each grid line assigned a value denoting its distance from the origin, the problem of locating any point becomes progressively easier. What does this mean?
    a. Normally, it would seem logical to assign a value of zero to the two base lines and measure outward from them. This, however, would require either that directions–N, S, E, or W–be always given with distances, or that all points south of the equator or west of the central meridian have negative values. This

inconvenience is eliminated by assigning "false values" to the base lines, resulting in positive values for all points within each zone. Distances are always measured RIGHT and UP (east and north as the reader faces the map), and the assigned values are called "false easting" and "false northing." (Figure 4-9).

91. What is the false easting value for each central meridian?
    a. 500,000 meters, and the false northing value for the equator is 0 meters when measuring in the northern hemisphere and 10,000,000 meters when measuring in the southern hemisphere.
92. What is the Universal Polar Stereographic (UPS) Grid used for?
    a. The UPS grid is used to represent the polar regions
93. What is the North Polar Area?
    a. The origin of the UPS grid applied to the north polar area is the north pole. The "north-south" base line is the line formed by the 0-degree and 180-degree meridians; the "east-west" base line is formed by the two 90-degree meridians.
94. What is the South Polar Area?
    a. The origin of the UPS grid in the south polar area is the south pole. The base lines are similar to those of the north polar area.
95. What is a Grid Zone Designation?
    a. The world is divided into 60 grid zones, which are large, regularly shaped geographic areas, each of which is given a unique identification called the grid zone designation.
96. How are 100,000-Meter Squares identified?
    a. Between 84°N and 80°S, each 6° by 8° or 6° by 12° zone is covered by 100,000-meter squares that are identified by the combination of two alphabetical letters. This identification is unique within the area covered by the grid zone designation. The first letter is the column designation; the second letter is the row designation (Figure 4- 11). The north and south polar areas are also divided into 100,000-meter squares by columns and rows. The 100,000-meter square identification letters are located in the grid reference box in the lower margin of the map.
97. How are Grid Coordinates determined?
    a. We have now divided the earth's surface into 6° by 8° quadrangles, and covered these with 100,000-meter squares. The military grid reference of a point consists of the numbers and letters indicating in which of these areas the point lies, plus the coordinates locating the point to the desired position within the 100,000-meter square. The next step is to tie in the coordinates of the point with the larger areas.
98. What do grid lines tell you on a map?
    a. The regularly spaced lines that make the UTM and the UPS grid on any large-scale maps are divisions of the 100,000-meter square; the lines are spaced at 10,000- or 1,000-meter intervals (Figure 4-12, page 4-14). Each of these lines is labeled at both ends of the map with its false easting or false northing value, showing its relation to the origin of the zone. Two digits of the values are printed in large type, and these same two digits appear at intervals along the grid lines

on the face of the map. These are called the principal digits, and represent the 10,000 and 1,000 digits of the grid value. They are of major importance to the map reader because they are the numbers he will use most often for referencing points. The smaller digits complete the UTM grid designation.

99. How are Grid Squares determined?

   a. The north-south and east-west grid lines intersect at 90°, forming grid squares. Normally, the size of one of these grid squares on large-scale maps is 1,000 meters (1 kilometer).

100. What is the primary tool for plotting grid coordinates?

   a. The primary tool for plotting grid coordinates is the grid coordinate scale. The grid coordinate scale divides the grid square more accurately than can be done by estimation, and the results are more consistent. When used correctly, it presents less chance for making errors. GTA 5-2-12 contains four types of coordinate scales

101. How can you determine grids without a coordinate scale?

   a. Without a Coordinate Scale. In order to determine grids without a coordinate scale, the reader simply refers to the north-south grid lines numbered at the bottom margin of any map. Then he reads RIGHT to the north-south grid line that precedes the desired point (this first set of two digits is the RIGHT reading). Then by referring to the east-west grid lines numbered at either side of the map, the map reader moves UP to the east-west grid line that precedes the desired point (these two digits are the UP reading).

102. How can you determine grids with a coordinate scale?

   a. With a Coordinate Scale. In order to use the coordinate scale for determining grid coordinates, the map user has to make sure that the appropriate scale is being used on the corresponding map, and that the scale is right side up. To ensure the scale is correctly aligned, place it with the zero-zero point at the lower left corner of the grid square. Keeping the horizontal line of the scale directly on top of the east-west grid line, slide it to the right until the vertical line of the scale touches the point for which the coordinates are desired (Figure 4-16, page 4-18). When reading coordinates, examine the two sides of the coordinate scale to ensure that the horizontal line of the scale is aligned with the east-west grid line, and the vertical line of the scale is parallel with the north-south grid line.

103. How are grid coordinates written and reported?

   a. Recording and Reporting Grid Coordinates. Coordinates are written as one continuous number without spaces, parentheses, dashes, or decimal points; they must always contain an even number of digits. Therefore, whoever is to use the written coordinates must know where to make the split between the RIGHT and UP readings. It is a military requirement that the 100,000-meter square identification letters be included in any point designation. Normally, grid coordinates are determined to the nearest 100 meters (six digits) for reporting locations. With practice, this can be done without using plotting scales. The location of targets and other point locations for fire support are determined to the nearest 10 meters (eight digits).

104. There is only one rule to remember when reading or reporting grid coordinates–always read to the:
    a. RIGHT and then UP. The first half of the reported set of coordinate digits represents the left-to-right (easting) grid label, and the second half represents the label as read from the bottom to top (northing). The grid coordinates may represent the location to the nearest 10-, 100-, or 1,000-meter increment.
105. What determines the level of precision of a grid coordinate?
    a. The precision of a point's location is shown by the number of digits in the coordinates; the more digits, the more precise the location.
106. Where is the grid reference box?
    a. Appears in the marginal information of each map sheet. It contains step-by-step instructions for using the grid and the U.S. Army military grid reference system. The grid reference box is divided into two parts.
107. What is the World Geographic Reference System (GEOREF)?
    a. This is a worldwide position reference system used primarily by the U.S. Air Force. It may be used with any map or chart that has latitude and longitude printed on it. Instructions for using GEOREF data are printed in blue and are found in the margin of aeronautical charts (Figure 4-20, page 4-24). This system is based upon a division of the earth's surface into quadrangles of latitude and longitude having a systematic identification code. It is a method of expressing latitude and longitude in a form suitable for rapid reporting and plotting. Figure 4-20 illustrates a sample grid reference box using GEOREF. The GEOREF system uses an identification code that has three main divisions.
108. What is the disadvantage of any standard system of location?
    a. the enemy, if he intercepts one of our messages using the system, can interpret the message and find our location. This possibility can be eliminated by using an authorized low-level numerical code to express locations. Army Regulation 380-40 outlines the procedures for obtaining authorized codes.
109. The authorized numerical code provides a capability for:
    a. encrypting map references and other numerical information that requires short-term security protection when, for operational reasons, the remainder of the message is transmitted in plain language. The system is published in easy-to-use booklets with sufficient material in each for one month's operation. Sample training editions of this type of system are available through the unit's communications and electronics officer.
110. What is a representative fraction?
    a. The numerical scale of a map indicates the relationship of distance measured on a map and the corresponding distance on the ground. This scale is usually written as a fraction and is called the representative fraction (RF). The RF is always written with the map distance as 1 and is independent of any unit of measure.

111. What does an RF of 1/50,000 mean?

a. An RF of 1/50,000 or 1:50,000 means that one unit of measure on the map is equal to 50,000 units of the same measure on the ground.

112. The situation may arise when a map or sketch has no RF or scale. How do you determine ground distance on the map?
    a. To be able to determine ground distance on such a map, the RF must be determined. There are two ways to do this:

113. What is the formula for representative fractions?
    a. 1/X = MD/GD
    b. RF = Representative Fraction
    c. MD = Map Distance
    d. GD = Ground Distance

114. What are graphic scales?
    a. A graphic scale is a ruler printed on the map and is used to convert distances on the map to actual ground distances. The graphic scale is divided into two parts. To the right of the zero, the scale is marked in full units of measure and is called the primary scale. To the left of the zero, the scale is divided into tenths and is called the extension scale. Most maps have three or more graphic scales, each using a different unit of measure (Figure 5-2, page 5-4). When using the graphic scale, be sure to use the correct scale for the unit of measure desired.

115. How do you determine straight-line distance between two points on a map?
    a. lay a straight-edged piece of paper on the map so that the edge of the paper touches both points and extends past them. Make a tick mark on the edge of the paper at each point

116. How do you convert the map distance to ground distance?
    a. move the paper down to the graphic bar scale, and align the right tick mark (b) with a printed number in the primary scale so that the left tick mark (a) is in the extension scale

117. How do you measure distance along a road, stream, or other curved line?
    a. the straight edge of a piece of paper is used. In order to avoid confusion concerning the point to begin measuring from and the ending point, an eight-digit coordinate should be given for both the starting and ending points. Place a tick mark on the paper and map at the beginning point from which the curved line is to be measured. Align the edge of the paper along a straight portion and make a tick mark on both map and paper when the edge of the paper leaves the straight portion of the line being measured Keeping both tick marks together (on paper and map), place the point of the pencil close to the edge of the paper on the tick mark to hold it in place. Then, pivot the paper until another straight portion of the curved line is aligned with the edge of the paper. Continue in this manner until the measurement is completed (B, Figure 5-5, page 5-6). When you have completed measuring the distance, move the paper to the graphic scale to determine the ground distance. The only tick marks you will be measuring the distance between are tick marks (a) and (b). The tick marks in between are not used

118. What is a technique that may be used to determine exact distance between two points when the edge of the paper exceeds the bar scale?

   a. slide the edge of the paper to the right until tick mark (a) is aligned with the edge of the extension scale. Make a tick mark on the paper, in line with the 2,000-meter mark (c) (A, Figure 5-7, page 5-8). Then slide the edge of the paper to the left until tick mark (b) is aligned with the zero.

119. At times you may want to know the distance from a point on the map to a point off the map. How can you do this?

   a. measure the distance from the start point to the edge of the map. The marginal notes give the road distance from the edge of the map to some towns, highways, or junctions off the map. To determine the total distance, add the distance measured on the map to the distance given in the marginal notes. Be sure the unit of measure is the same.

120. When measuring distance in statute or nautical miles, what should you do?

   a. round it off to the nearest one-tenth of a mile and make sure the appropriate bar scale is used.

121. Distance measured on a map does not take into consideration what factors?

   a. the rise and fall of the land. All distances measured by using the map and graphic scales are flat distances. Therefore, the distance measured on a map will increase when actually measured on the ground. This must be taken into consideration when navigating across country.

122. The amount of time required to travel a certain distance on the ground is an important factor in most military operations. This can be determined if a map of the area is available and a graphic time-distance scale is constructed for use with the map. What are the factors that determine required travel time?

   a. R = Rate of travel (speed)
   b. T = Time
   c. D = Distance (ground distance)
   d. T = D/R

123. How can you construct a time-distance scale?

   a. Mark off the total distance on a line by referring to the graphic scale of the map or, if this is impracticable, compute the length of the line as follows: Convert the ground distance to centimeters: 12 kilometers x 100,000 (centimeters per kilometer) = 1,200,000 centimeters. Find the length of the line to represent the distance at map scale. Construct a line 24 centimeters in length. Divide the line by the rate of march into three parts, each part representing the distance traveled in one hour, and label Divide the scale extension (left portion) into the desired number of lesser time divisions.

124. What are common errors people make while moving?

   a. Determining distance is the most common source of error encountered while moving either mounted or dismounted. There may be circumstances where you are unable to determine distance using your map or where you are without a map. It is, therefore, essential to learn methods by which you can accurately pace, measure, use subtense, or estimate distances on the ground.

125. What is pace count? How do you establish pace count?
    a. Pace Count. Another way to measure ground distance is the pace count. A pace is equal to one natural step, about 30 inches long. To accurately use the pace count method, you must know how many paces it takes you to walk 100 meters. To determine this, you must walk an accurately measured course and count the number of paces you take. A pace course can be as short as 100 meters or as long as 600 meters. The pace course, regardless of length, must be on similar terrain to that you will be walking over. It does no good to walk a course on flat terrain and then try to use that pace count on hilly terrain. To determine your pace count on a 600-meter course, count the paces it takes you to walk the 600 meters, then divide the total paces by 6. The answer will give you the average paces it takes you to walk 100 meters. It is important that each person who navigates while dismounted knows his pace count. There are many methods to keep track of the distance traveled when using the pace count. Some of these methods are: Put a pebble in your pocket every time you have walked 100 meters according to your pace count; tie knots in a string; or put marks in a notebook. Do not try to remember the count; always use one of these methods or design your own method.

126. Certain conditions affect your pace count in the field, and you must allow for them by making adjustments. What impact your pace count in the field?
    a. Slopes. Your pace lengthens on a downslope and shortens on an upgrade. Keeping this in mind, if it normally takes you 120 paces to walk 100 meters, your pace count may increase to 130 or more when walking up a slope.
    b. (b) Winds. A head wind shortens the pace and a tail wind increases it.
    c. (c) Surfaces. Sand, gravel, mud, snow, and similar surface materials tend to shorten the pace.
    d. (d) Elements. Falling snow, rain, or ice cause the pace to be reduced in length.
    e. (e) Clothing. Excess clothing and boots with poor traction affect the pace length.
    f. (f) Visibility. Poor visibility, such as in fog, rain, or darkness, will shorten your pace.

127. What can be used to measure distance traveled in a vehicle?
    a. Distances can be measured by an odometer, which is standard equipment on most vehicles. Readings are recorded at the start and end of a course and the difference is the length of the course.

128. How do you convert kilometers to miles?
    a. multiply the number of kilometers by 0.62.

129. How do you convert miles to kilometers?
    a. divided the number of miles by 0.62.

130. What is the subtense method?
    a. The subtense method is a fast method of determining distance and yields accuracy equivalent to that obtained by measuring distance with a premeasured piece of wire.

131. An advantage is that a horizontal distance is obtained indirectly; that is, the distance is computed rather than measured. This allows subtense to be used over terrain where obstacles, such as streams, ravines, or steep slopes, may prohibit other methods of determining distance. What is an application of the subtense method?
    a. The principle used in determining distance by the subtense method is similar to that used in estimating distance by the mil relation formula. The field artillery (FA) application of the mil relation formula involves only estimations. It is not accurate enough for survey purposes. However, the subtense method uses precise values with a trigonometric solution. Subtense is based on a principle of visual perspective—the farther away an object is, the smaller it appears.

132. The following two procedures are involved in subtense measurement:
    a. • Establishing a base of known length.
    b. • Measuring the angle of that base by use of the aiming circle.

133. If a base of another length is desired, a distance can be computed by using what formula?
    a. Distance = 1/2 (base in meters)
    b. Tan (1/2) (in mils)

134. What is the 100-Meter Unit-of-Measure Method?
    a. To use this method, the soldier must be able to visualize a distance of 100 meters on the ground. For ranges up to 500 meters, he determines the number of 100-meter increments between the two objects he wishes to measure. Beyond 500 meters, the soldier must select a point halfway to the object(s) and determine the number of 100-meter increments to the halfway point, then double it to find the range to the object.

135. What is the Flash-to-Bang Method to determine distance?
    a. To use this method to determine range to an explosion or enemy fire, begin to count when you see the flash. Count the seconds until you hear the weapon fire. This time interval may be measured with a stopwatch or by using a steady count, such as one-thousand-one, one-thousand-two, and so forth, for a three-second estimated count. If you must count higher than 10 seconds, start over with one. Multiply the number of seconds by 330 meters to get the approximate range (FA uses 350 meters instead).

136. How do you develop Proficiency in the previous methods?
    a. The methods discussed above are used only to estimate range (Table 5-1). Proficiency in both methods requires constant practice. The best training technique is to require the soldier to pace the range after he has estimated the distance. In this way, the soldier discovers the actual range for himself, which makes a greater impression than if he is simply told the correct range.

137. Degree. The most common unit of measure is the degree (o) with its subdivisions of minutes (') and seconds ("). What do one minute and degree equal?
    a. 1 degree = 60 minutes.
    b. 1 minute = 60 seconds.

138. What is another unit of measure used for artillery and mortar gunnery?
   a. Another unit of measure, the mil (abbreviated m/ in graphics), is used mainly in artillery, tank, and mortar gunnery. The mil expresses the size of an angle formed when a circle is divided into 6,400 angles, with the vertex of the angles at the center of the circle. A relationship can be established between degrees and mils. A circle equals 6400 mils divided by 360 degrees, or 17.78 mils per degree. To convert degrees to mils, multiply degrees by 17.78.
139. What is the grad?
   a. The grad is a metric unit of measure found on some foreign maps. There are 400 grads in a circle (a 90-degree right angle equals 100 grads). The grad is divided into 100 centesimal minutes (centigrads) and the minute into 100 centesimal seconds (milligrads).
140. What is true north?
   a. True north is defined as a line from any point on the earth's surface to the north pole. All lines of longitude are true north lines. True north is usually represented by a star. In order to measure something, there must always be a starting point or zero measurement. To express direction as a unit of angular measure, there must be a starting point or zero measure and a point of reference. These two points designate the base or reference line.
141. What are the three base lines?
   a. There are three base lines–true north, magnetic north, and grid north. The most commonly used are magnetic and grid.
   b. What is magnetic north?
   c. Magnetic north is the direction to the north magnetic pole, as indicated by the north-seeking needle of a magnetic instrument. The magnetic north is usually symbolized by a line ending with half of an arrowhead. Magnetic readings are obtained with magnetic instruments such as lensatic and M2 compasses.
142. What is grid north?
   a. Grid north is the north that is established by using the vertical grid lines on the map. Grid north may be symbolized by the letters GN or the letter "y".
143. What is an azimuth?
   a. An azimuth is defined as a horizontal angle measured clockwise from a north base line. This north base line could be true north, magnetic north, or grid north. The azimuth is the most common military method to express direction. When using an azimuth, the point from which the azimuth originates is the center of an imaginary circle (Figure 6-2). This circle is divided into 360 degrees or 6400 mils.
144. What is a back azimuth?
   a. A back azimuth is the opposite direction of an azimuth. It is comparable to doing "about face." To obtain a back azimuth from an azimuth, add 180 degrees if the azimuth is 180 degrees or less; subtract 180 degrees if the azimuth is 180 degrees or more (Figure 6-3). The back azimuth of 180 degrees may be stated as 0 degrees or 360 degrees. For mils, if the azimuth is less than 3200 mils, add 3200 mils; if the azimuth is more than 3200 mils, subtract 3200 mils.

145. How is a magnetic azimuth determined?

a. The magnetic azimuth is determined by using magnetic instruments such as lensatic and M2 compasses. (See Chapter 9 for details.)

146. When an azimuth is plotted on a map between point A (starting point) and point B, the points are joined together by a straight line. What measures the angle between those points?

a. A protractor is used to measure the angle between grid north and the drawn line, and this measured azimuth is the grid azimuth

147. What are the types of protractors used?

a. There are several types of protractors—full circle, half circle, square, and rectangular All of them divide the circle into units of angular measure, and each has a scale around the outer edge and an index mark. The index mark is the center of the protractor circle from which all directions are measured.

148. The military protractor, GTA 5-2-12, contains two scales. What are they?

a. one in degrees (inner scale) and one in mils (outer scale). This protractor represents the azimuth circle.

149. What is the degree scale?

a. The degree scale is graduated from 0 to 360 degrees with each tick mark representing one degree. A line from 0 to 180 degrees is called the base line of the protractor. The index or center of the protractor is where the base line intersects the horizontal line, between 90 and 270 degrees. When using the protractor, the base line is always oriented parallel to a north-south grid line. The 0- or 360-degree mark is always toward the top or north on the map and the 90-degree mark is to the right.

150. How do you determine a grid azimuth?

a. (1) To determine the grid azimuth—
b. (a) Draw a line connecting the two points (A and B).
c. (b) Place the index of the protractor at the point where the drawn line crosses a vertical (north-south) grid line.
d. (c) Keeping the index at this point, align the 0- to 180-degree line of the protractor on the vertical grid line.
e. (d) Read the value of the angle from the scale; this is the grid azimuth from point A to point B.

151. How do you plot an azimuth from a known point on a map?

a. To plot an azimuth from a known point on a map:
b. (a) Convert the azimuth from magnetic to grid, if necessary (see paragraph 6-6).
c. (b) Place the protractor on the map with the index mark at the center of mass of the known point and the base line parallel to a north-south grid line.
d. (c) Make a mark on the map at the desired azimuth.
e. (d) Remove the protractor and draw a line connecting the known point and the mark on the map. This is the grid direction line (azimuth).

152. How do you plot an accurate azimuth with your protactor?

- a. To obtain an accurate reading with the protractor (to the nearest degree or 10 mils), there are two techniques to check that the base line of the protractor is parallel to a north-south grid line.
- b. (1) Place the protractor index where the azimuth line cuts a north-south grid line, aligning the base line of the protractor directly over the intersection of the azimuth line with the north-south grid line. The user should be able to determine whether the initial azimuth reading was correct.
- c. (2) The user should re-read the azimuth between the azimuth and north-south grid line to check the initial azimuth.
- d. (3) Note that the protractor is cut at both the top and bottom by the same north-south grid line. Count the number of degrees from the 0-degree mark at the top of the protractor to this north-south grid line and then count the number of degrees from the 180-degree mark at the bottom of the protractor to this same grid line. If the two counts are equal, the protractor is properly aligned.

153. What is the Grid-Magnetic Angle?

- a. The G-M angle value is the angular size that exists between grid north and magnetic north. It is an arc, indicated by a dashed line, that connects the grid-north and magnetic-north prongs. This value is expressed to the nearest 1/2 degree, with mil equivalents shown to the nearest 10 mils. The G-M angle is important to the map reader/land navigator because azimuths translated between map and ground will be in error by the size of the declination angle if not adjusted for it.

154. What is Grid Convergence?

- a. An arc indicated by a dashed line connects the prongs for true north and grid north. The value of the angle for the center of the sheet is given to the nearest full minute with its equivalent to the nearest mil. These data are shown in the form of a grid-convergence note.

155. Why are grid to magnetic azimuth conversions important?

- a. There is an angular difference between the grid north and the magnetic north. Since the location of magnetic north does not correspond exactly with the grid-north lines on the maps, a conversion from magnetic to grid or vice versa is needed.

156. What do the notes tell you about the G-M angle conversion?

- a. Simply refer to the conversion notes that appear in conjunction with the diagram explaining the use of the G-M angle (Figure 6-8). One note provides instructions for converting magnetic azimuth to grid azimuth; the other, for converting grid azimuth to magnetic azimuth. The conversion (add or subtract) is governed by the direction of the magnetic-north prong relative to that of the grid-north prong.

157. How do you make a G-M conversion without notes?

- a. In some cases, there are no declination conversion notes on the margin of the map; it is necessary to convert from one type of declination to another. A magnetic compass gives a magnetic azimuth; but in order to plot this line on a gridded map, the magnetic azimuth value must be changed to grid azimuth. The declination diagram is used for these conversions. A rule to remember when solving such problems is: No matter where the azimuth line points, the angle to it is always measured clockwise from the reference direction (base line).

158. How do you determine the G-M angle?

a. (a) Draw a vertical or grid-north line (prong). Always align this line with the vertical lines on a map (Figure 6-9).
b. (b) From the base of the grid-north line (prong), draw an arbitrary line (or any azimuth line) at a roughly right angle to north, regardless of the actual value of the azimuth in degrees
c. (Figure 6-9).
d. (c) Examine the declination diagram on the map and determine the direction of the magnetic north (right-left or east-west) relative to that of the grid-north prong. Draw a magnetic prong from the apex of the grid-north line in the desired direction (Figure 6-9).
e. (d) Determine the value of the G-M angle. Draw an arc from the grid prong to the magnetic prong and place the value of the G-M angle (Figure 6-9).
f. (e) Complete the diagram by drawing an arc from each reference line to the arbitrary line. A glance at the completed diagram shows whether the given azimuth or the desired
g. azimuth is greater, and, thus, whether the known difference between the two must be added or subtracted.
h. (f) The inclusion of the true-north prong in relationship to the conversion is of little importance.

159. What are considerations when working with a map having an east G-M angle?

a. (a) To plot a magnetic azimuth on a map, first change it to a grid azimuth (Figure 6-10).
b. (b) To use a magnetic azimuth in the field with a compass, first change the grid azimuth plotted on a map to a magnetic azimuth (Figure 6-11).
c. (c) Convert a grid azimuth to a magnetic azimuth when the G-M angle is greater than a grid azimuth (Figure 6-12).

160. What are considerations when working with a map having a west G-M angle?

a. (a) To plot a magnetic azimuth on a map, first convert it to a grid azimuth (Figure 6-13).
b. (b) To use a magnetic azimuth in the field with a compass, change the grid azimuth plotted on a map to a magnetic azimuth (Figure 6-14).
c. (c) Convert a magnetic azimuth when the G-M angle is greater than the magnetic azimuth (Figure 6-15).
d. (3) The G-M angle diagram should be constructed and used each time the conversion of azimuth is required. Such procedure is important when working with a map for the first time. It also may be convenient to construct a G-M angle conversion table on the margin of the map.

161. When converting azimuths, exercise extreme care when adding and subtracting the G-M angle. Why is this?
   a. A simple mistake of 1 degree could be significant in the field.
162. What are intersections?
   a. Intersection is the location of an unknown point by successively occupying at least two (preferably three) known positions on the ground and then map sighting on the unknown location. It is used to locate distant or inaccessible points or objects such as enemy targets and danger areas. There are two methods of intersection: the map and compass method and the straightedge method
163. How do you find locations by intersection using a map and compass?
   a. (1) Orient the map using the compass. Locate and mark your position on the map, Determine the magnetic azimuth to the unknown position using the compass. Convert the magnetic azimuth to grid azimuth. Draw a line on the map from your position on this grid azimuth. Move to a second known point and repeat steps 1, 2, 3, 4, and 5. The location of the unknown position is where the lines cross on the map. Determine the grid coordinates to the desired accuracy.
164. What is the straightedge method for intersection?
   a. b. The straightedge method is used when a compass is not available. When using it—
   b. Orient the map on a flat surface by the terrain association method. Locate and mark your position on the map. Lay a straightedge on the map with one end at the user's position (A) as a pivot point; then, rotate the straightedge until the unknown point is sighted along the edge. Draw a line along the straightedge Repeat the above steps at position (B) and check for accuracy. The intersection of the lines on the map is the location of the unknown point (C). Determine the grid coordinates to the desired accuracy (Figure 6-17).
165. What is resection?
   a. Resection is the method of locating one's position on a map by determining the grid azimuth to at least two well-defined locations that can be pinpointed on the map. For greater accuracy, the desired method of resection would be to use three or more well-defined locations.
   b. When using the map and compass method (Figure 6-18)—
   c. Orient the map using the compass. Identify two or three known distant locations on the ground and mark them on the map. Measure the magnetic azimuth to one of the known positions from your location using a compass. Convert the magnetic azimuth to a grid azimuth. Convert the grid azimuth to a back azimuth. Using a protractor, draw a line for the back azimuth on the map from the known position back toward your unknown position. Repeat these steps for a second position and a third position, if desired. The intersection of the lines is your location. Determine the grid coordinates to the desired accuracy.
166. What are considerations for using the straightedge method for resection?
   a. Orient the map on a flat surface by the terrain association method. Locate at least two known distant locations or prominent features on the ground and mark them on the map. Lay a straightedge on the map using a known position as a

pivot point. Rotate the straightedge until the known position on the map is aligned with the known position on the ground. Draw a line along the straightedge away from the known position on the ground toward your position. Repeat 3 and 4 using a second known position. The intersection of the lines on the map is your location. Determine the grid coordinates to the desired accuracy.

167. What is modified resection?
   a. Modified resection is the method of locating one's position on the map when the person is located on a linear feature on the ground, such as a road, canal, or stream. Proceed as follows:
   b. a. Orient the map using a compass or by terrain association.
   c. b. Find a distant point that can be identified on the ground and on the map.
   d. c. Determine the magnetic azimuth from your location to the distant known point.
   e. d. Convert the magnetic azimuth to a grid azimuth.
   f. e. Convert the grid azimuth to a back azimuth. Using a protractor, draw a line for the back azimuth on the map from the known position back toward your unknown position.
   g. f. The location of the user is where the line crosses the linear feature. Determine the grid coordinates to the desired accuracy.

168. A method of locating or plotting an unknown position from a known point by giving a direction and a distance along that direction line is called polar plot. The following elements must be present when using polar plot:
   a. • Present known location on the map.
   b. • Azimuth (grid or magnetic).
   c. • Distance (in meters).

169. What are overlays used for?
   a. display military operations with enemy and friendly troop dispositions, and as supplements to orders sent to the field. They show detail that will aid in understanding the orders, displays of communication networks, and so forth. They are also used as annexes to reports made in the field because they can clarify matters that are difficult to explain clearly in writing.

170. What are the three steps in making a map overlay?
   a. orienting the overlay material, plotting and symbolizing the detail, and adding the required marginal information. Orient the overlay over the place on the map to be annotated. Then, if possible, attach it to the edges of the map with tape. Trace the grid intersections nearest the two opposite corners of the overlay using a straightedge, and label each with the proper grid coordinates. These register marks show exactly where the overlay fits on the map; without them, the overlay is difficult to orient. It is imperative that absolute accuracy be maintained in plotting the register marks, as the smallest mistake will throw off the overlay.

171. What is an effective method for plotting an overlay?
   a. (1) Use standard topographic or military symbols where possible. Nonstandard symbols invented by the author must be identified in a legend on the overlay. Depending on the

b. conditions under which the overlay is made, it may be advisable to plot the positions first on the map, then trace them onto the overlay. Since the overlay is to be used as a supplement to orders or reports and the recipient will have an identical map, show only that detail with which the report is directly concerned.
c. (2) If you have observed any topographic or cultural features that are not shown on the map, such as a new road or a destroyed bridge, plot their positions as accurately as possible
d. on the overlay and mark with the standard topographic symbol.
e. (3) If difficulty in seeing through the overlay material is encountered while plotting or tracing detail, lift the overlay from time to time to check orientation of information being added in reference to the base.

172. When all required detail has been plotted or traced on the overlay, print information as close to the lower right-hand corner as detail permits (Figure 7-2). This information includes what data?
    a. (1) Title and Objective. This tells the reader why the overlay was made and may also give the actual location. For example, "Road reconnaissance" is not as specific as "Route 146 road reconnaissance."
    b. (2) Time and Date. Any overlay should contain the latest possible information. An overlay received in time is valuable to the planning staff and may affect the entire situation; an overlay that has been delayed for any reason may be of little use. Therefore, the exact time the information was obtained aids the receivers in determining its reliability and usefulness.
    c. (3) Map Reference. The sheet name, sheet number, map series number, and scale must be included. If the reader does not have the same map that was used for the overlay, this
    d. provides the information necessary to obtain it.
    e. (4) Author. The name, rank, and organization of the author, supplemented with a date and time of preparation of the overlay, tells the reader if there was a time difference between
    f. when the information was obtained and when it was reported.
    g. (5) Legend. If it is necessary to invent nonstandard symbols to show the required information, the legend must show what these symbols mean.
    h. (6) Security Classification. This must correspond to the highest classification of either the map or the information placed on the overlay. This will also be stated if the information and map are unclassified. The locations of the classification notes are shown in Figure 7-2, and the notes will appear in both locations as shown.
    i. (7) Additional Information. Any other information that amplifies the overlay will also be included. Make it as brief as possible.
173. The lensatic compass (Figure 9-1) consists of three major parts. What are they?
    a. the cover, the base, and the lens.
174. What is the purpose of the compass cover?
    a. The compass cover protects the floating dial. The cover contains the sighting wire (front sight) and two luminous sighting slots or dots used for night navigation.

175. The base of the compass contains what parts?

a. (1) The floating dial is mounted on a pivot so it can rotate freely when the compass is held level. Printed on the dial in luminous figures are an arrow and the letters E and W. The arrow always points to magnetic north and the letters fall at east (E) 90 degrees and west (W) 270 degrees on the dial. There are two scales; the outer scale denotes mils and the inner scale (normally in red) denotes degrees. Encasing the floating dial is a glass containing a fixed black index line. The bezel ring is a ratchet device that clicks when turned. It contains 120 clicks when rotated fully; each click is equal to 3 degrees. A short luminous line that is used in conjunction with the north-seeking arrow during navigation is contained in the glass face of the bezel ring. The thumb loop is attached to the base of the compass.

176. What is the compass lens used for?

a. The lens is used to read the dial, and it contains the rear-sight slot used in conjunction with the front for sighting on objects. The rear sight also serves as a lock and clamps the dial when closed for its protection. The rear sight must be opened more than 45 degrees to allow the dial to float freely.

177. Why must your compass be inspected before use?

a. A detailed inspection is required when first obtaining and using a compass. One of the most important parts to check is the floating dial, which contains the magnetic needle. The user must also make sure the sighting wire is straight, the glass and crystal parts are not broken, the numbers on the dial are readable, and most important, that the dial does not stick.

178. What are the effects of Metal and Electricity on your compass?

a. Metal objects and electrical sources can affect the performance of a compass. However, nonmagnetic metals and alloys do not affect compass readings.

179. What separation distances are suggested to ensure proper functioning of a compass?

a. High-tension power lines .... 55 meters.
b. Field gun, truck, or tank.. 18 meters.
c. Telegraph or telephone wires and barbed wire....... 10 meters.
d. Machine gun .... 2 meters.
e. Steel helmet or rifle.. 1/2 meter.

180. Are compasses accurate?

a. A compass in good working condition is very accurate. However, a compass has to be checked periodically on a known line of direction, such as a surveyed azimuth, using a declination station. Compasses with more than 3 degrees variation should not be used.

181. What are methods for protecting your compass?

a. If traveling with the compass unfolded, make sure the rear sight is fully folded down onto the bezel ring. This will lock the floating dial and prevent vibration, as well as protect the crystal and rear sight from damage.

182. How do you navigate using the centerfold technique?

a. Using the Centerhold Technique. First, open the compass to its fullest so that the cover forms a straightedge with the base. Move the lens (rear sight) to the rearmost position, allowing the dial to float freely. Next, place your thumb through the thumb loop, form a steady base with your third and fourth fingers, and extend your index finger along the side of the compass. Place the thumb of the other hand between the lens (rear sight) and the bezel ring; extend the index finger along the remaining side of the compass, and the remaining fingers around the fingers of the other hand. Pull your elbows firmly into your sides; this will place the compass between your chin and your belt. To measure an azimuth, simply turn your entire body toward the object, pointing the compass cover directly at the object. Once you are pointing at the object, look down and read the azimuth from beneath the fixed black index line (Figure 9-2).

183. The center hold technique method offers what following advantages over the sighting technique?

a. • It is faster and easier to use.
b. • It can be used under all conditions of visibility.
c. • It can be used when navigating over any type of terrain.
d. • It can be used without putting down the rifle; however, the rifle must be slung well back over either shoulder.
e. • It can be used without removing eyeglasses.

184. What is the compass-to-cheek technique?

a. Fold the cover of the compass containing the sighting wire to a vertical position; then fold the rear sight slightly forward. Look through the rear-sight slot and align the front-sight hairline with the desired object in the distance. Glance down at the dial through the eye lens to read the azimuth

185. Although different models of the lensatic compass vary somewhat in the details of their use, the principles are the same. What is the process for setting an azimuth?

a. (1) During daylight hours or with a light source—
b. Hold the compass level in the palm of the hand. Rotate it until the desired azimuth falls under the fixed black index line (for example, 320 degrees), maintaining the azimuth as prescribed. Turn the bezel ring until the luminous line is aligned with the north-seeking arrow. Once the alignment is obtained, the compass is preset. To follow an azimuth, assume the centerhold technique and turn your body until the north-seeking arrow is aligned with the luminous line. Proceed forward in the direction of the front cover's sighting wire, which is aligned with the fixed black index line that contains the desired azimuth. During limited visibility, an azimuth may be set on the compass by the click method. Remember that the bezel ring contains 3-degree intervals (clicks). Rotate the bezel ring until the luminous line is over the fixed black index line. Find the desired azimuth and divide it by three. The result is the number of clicks that you have to rotate the bezel ring. Count the desired number of clicks. If the desired azimuth is smaller than 180 degrees, the number of clicks on the bezel ring should be counted in a counterclockwise direction. For example, the desired

azimuth is 51 degrees; 51 degrees ÷ 3 = 17 clicks counterclockwise. If the desired azimuth is larger than 180 degrees, subtract the number of degrees from 360 degrees and divide by 3 to obtain the number of clicks. Count them in a clockwise direction. For example, the desired azimuth is 330 degrees; 360 degrees − 330 degrees = 30 ÷ 3 = 10 clicks clockwise. With the compass preset as described above, assume a centerhold technique and rotate your body until the north-seeking arrow is aligned with the luminous line on the bezel. Proceed forward in the direction of the front cover's luminous dots, which are aligned with the fixed black index line containing the azimuth. When the compass is to be used in darkness, an initial azimuth should be set while light is still available, if possible. With the initial azimuth as a base, any other azimuth that is a multiple of three can be established using the clicking feature of the bezel ring.

186. Bypassing an Obstacle. To bypass enemy positions or obstacles and still stay oriented, detour around the obstacle by moving at right angles for specified distances. What are the steps for bypassing obstacles?

  a. (1) For example, while moving on an azimuth of 90 degrees change your azimuth to 180 degrees and travel for 100 meters. Change your azimuth to 90 degrees and travel for 150 meters. Change your azimuth to 360 degrees and travel for 100 meters. Then, change your azimuth to 90 degrees and you are back on your original azimuth line Bypassing an unexpected obstacle at night is a fairly simple matter. To make a 90-degree turn to the right, hold the compass in the centerhold technique; turn until the center of the luminous letter E is under the luminous line (do not move the bezel ring). To make a 90-degree turn to the left, turn until the center of the luminous letter W is under the luminous line. This does not require changing the compass setting (bezel ring), and it ensures accurate 90-degree turns.

187. What is a deliberate offset?

  a. A deliberate offset is a planned magnetic deviation to the right or left of an azimuth to an objective. Use it when the objective is located along or in the vicinity of a linear feature such as a road or stream. Because of errors in the compass or in map reading, the linear feature may be reached without knowing whether the objective lies to the right or left. A deliberate offset by a known number of degrees in a known direction compensates for possible errors and ensures that upon reaching the linear feature, the user knows whether to go right or left to reach the objective. Ten degrees is an adequate offset for most tactical uses. Each degree offset moves the course about 18 meters to the right or left for each 1,000 meters traveled. For example, in Figure 9-6, the number of degrees offset is 10. If the distance traveled to "X" in 1,000 meters, then "X" is located about 180 meters to the right of the objective.

188. Shadow-Tip Method. This simple and accurate method of finding direction by the sun consists of four basic steps. What are they?

  a. Step 1. Place a stick or branch into the ground at a level spot where a distinctive shadow will be cast. Mark the shadow tip with a stone, twig, or other means. This first shadow mark is always the west direction.

   b. Step 2. Wait 10 to 15 minutes until the shadow tip moves a few inches. Mark the new position of the shadow tip in the same way as the first.
   c. Step 3. Draw a straight line through the two marks to obtain an approximate east-west line.
   d. Step 4. Standing with the first mark (west) to your left, the other directions are simple; north is to the front, east is to the right, and south is behind you.

189. A line drawn perpendicular to the east-west line at any point is the approximate north-south line. What should you do if you're uncertain which line is east or west?
   a. If you are uncertain which direction is east and which is west, observe this simple rule—the first shadow-tip mark is always in the west direction, everywhere on earth.

190. How can you find the time of day using sticks?
   a. move the stick to the intersection of the east-west line and the north-south line, and set it vertically in the ground. The west part of the east-west line indicates 0600 hours, and the east part is 1800 hours, anywhere on earth, because the basic rule always applies. The north-south line now becomes the noon line. The shadow of the stick is an hour hand in the shadow clock, and with it you can estimate the time using the noon line and the 6 o'clock line as your guides. Depending on your location and the season, the shadow may move either clockwise or counterclockwise, but this does not alter your manner of reading the shadow clock. The shadow clock is not a timepiece in the ordinary sense. It makes every day 12 unequal hours long, and always reads 0600 hours at sunrise and 1800 hours at sunset.

191. The shadow clock time is closest to conventional clock time at midday, but how does the passage of time change with location?
   a. But the spacing of the other hours compared to conventional time varies somewhat with the locality and the date. However, it does provide a satisfactory means of telling time in the absence of properly set watches.

192. Where is the shadow-tip method not to be used?
   a. The shadow-tip system is not intended for use in polar regions, which the Department of Defense defines as being above 60 degrees latitude in either hemisphere. Distressed persons in these areas are advised to stay in one place so that search/rescue teams can easily find them. The presence and location of all aircraft and ground parties in polar regions are reported to and checked regularly by governmental or other agencies, and any need for help becomes quickly known.

193. What is the watch method for determining true north and true south?
   a. A watch can be used to determine the approximate true north and true south. In the north temperate zone only, the hour hand is pointed toward the sun. A south line can be found midway between the hour hand and 1200 hours, standard time. If on daylight savings time, the north-south line is found between the hour hand and 1300 hours. If there is any doubt as to which end of the line is north, remember that the sun is in the east before noon and in the west after noon.

194. The watch may also be used to determine direction in the south temperate zone; however, the method is different. How is it different from the previous method?

   a. The 1200-hour dial is pointed toward the sun, and halfway between 1200 hours and the hour hand will be a north line. If on daylight savings time, the north line lies midway between the hour hand and 1300 hours (Figure 9-8).

195. The watch method can be in error, especially in the lower latitudes, and may cause circling. How can you avoid this?

   a. To avoid this, make a shadow clock and set your watch to the time indicated. After traveling for an hour, take another shadow-clock reading. Reset your watch if necessary.

196. Less than 60 of about 5,000 stars visible to the eye are used by navigators. What does this mean?

   a. The stars seen as we look up at the sky at night are not evenly scattered across the whole sky. Instead they are in groups called constellations. The constellations that we see depends partly on where we are located on the earth, the time of the year, and the time of the night. The night changes with the seasons because of the journey of the earth around the sun, and it also changes from hour to hour because the turning of the earth makes some constellations seem to travel in a circle.

197. There is one star that is in almost exactly the same place in the sky all night long every night. What star is it?

   a. It is the North Star, also known as the Polar Star or Polaris.

198. What are some of the characteristics of the North Star?

   a. The North Star is less than 1 degree off true north and does not move from its place because the axis of the earth is pointed toward it. The North Star is in the group of stars called the Little Dipper. It is the last star in the handle of the dipper. There are two stars in the Big Dipper, which are a big help when trying to find the North Star. They are called the Pointers, and an imaginary line drawn through them five times their distance points to the North Star. The farther one goes north, the higher the North Star is in the sky, and above latitude 70 degrees, it is too high in the sky to be useful Many stars are brighter than the North Star, but none is more important because of its location. However, the North Star can only be seen in the northern hemisphere so it cannot serve as a guide south of the equator.

199. Depending on the star selected for navigation, azimuth checks are necessary. How often should they be made?

   a. A star near the north horizon serves for about half an hour. When moving south, azimuth checks should be made every 15 minutes. When traveling east or west, the difficulty of staying on azimuth is caused more by the likelihood of the star climbing too high in the sky or losing itself behind the western horizon than it is by the star changing direction angle. When this happens, it is necessary to change to another guide star. The Southern Cross is the main constellation used as a guide south of the equator, and the general directions for using north and south stars are reversed. When navigating using the stars as guides, the user must know the different constellation shapes and their locations throughout the world

200. What is the GPS?
   a. The GPS is a space-based, global, all-weather, continuously available, radio positioning navigation system. It is highly accurate in determining position location derived from signal triangulation from a satellite constellation system. It is capable of determining latitude, longitude, and altitude of the individual user. It is being fielded in hand-held, manpack, vehicular, aircraft, and watercraft configurations. The GPS receives and processes data from satellites on either a simultaneous or sequential basis. It measures the velocity and range with respect to each satellite, processes the data in terms of an earth-centered, earth-fixed coordinate system, and displays the information to the user in geographic or military grid coordinates.

201. What does the GPS provide you?
   a. The GPS can provide precise steering information, as well as position location. The receiver can accept many checkpoints entered in any coordinate system by the user and convert them to the desired coordinate system. The user then calls up the desired checkpoint and the receiver will display direction and distance to the checkpoint. The GPS does not have inherent drift, an improvement over the Inertial Navigation System, and the receiver will automatically update its position.

202. What are some specific used for the GPS?
   a. Specific uses for the GPS are position location; navigation; weapon location; target and sensor location; coordination of firepower; scout and screening operations; combat resupply; location of obstacles, barriers, and gaps; and communication support. The GPS also has the potential to allow units to train their Soldiers and provide the following:
   b. • Performance feedback.
   c. • Knowledge of routes taken by the Soldier.
   d. • Knowledge of errors committed by the Soldier.
   e. • Comparison of planned versus executed routes.
   f. • Safety and control of lost and injured Soldiers.

203. What is layer tinting?
   a. Layer tinting is a method of showing relief by color. A different color is used for each band of elevation. Each shade of color, or band, represents a definite elevation range. A legend is printed on the map margin to indicate the elevation range represented by each color. However, this method does not allow the map user to determine the exact elevation of a specific point—only the range.

204. What are form lines?
   a. Form lines are not measured from any datum plane. Form lines have no standard elevation and give only a general idea of relief. Form lines are represented on a map as dashed lines and are never labeled with representative elevations.

205. What is relief shading?
   a. Relief shading indicates relief by a shadow effect achieved by tone and color that results in the darkening of one side of terrain features such as hills and ridges.

The darker the shading, the steeper the slope. Shaded relief is sometimes used in conjunction with contour lines to emphasize these features.

206. What hachures?

   a. Hachures are short, broken lines used to show relief. Hachures are sometimes used with contour lines. They do not represent exact elevations, but are mainly used to show large, rocky outcrop areas. Hachures are used extensively on small-scale maps to show mountain ranges, plateaus, and mountain peaks.

207. What are contour lines?

   a. Contour lines are the most common method of showing relief and elevation on a standard topographic map. A contour line represents an imaginary line on the ground, above or below sea level. All points on the contour line are at the same elevation. The elevation represented by contour lines is the vertical distance above or below sea level. The three types of contour lines (Figure 10-1, page 10-2) used on a standard topographic map are index, intermediate, and supplementary.

208. What are index conour lines?

   a. Starting at zero elevation or mean sea level, every fifth contour line is a heavier line. These are known as index contour lines. Normally, each index contour line is numbered at some point. This number is the elevation of that line.

209. What are intermediate contour lines?

   a. The contour lines falling between the index contour lines are called intermediate contour lines. These lines are finer and do not have their elevations given. There are normally four intermediate contour lines between index contour lines.

210. What are supplementary contour lines?

   a. These contour lines resemble dashes. They show changes in elevation of at least one-half the contour interval. Supplementary lines are normally found where there is very little change in elevation such as on fairly level terrain.

211. Before the elevation of any point on the map can be determined, the user must know the contour interval for the map he is using. Where is the contour interval measurement?

   a. The contour interval measurement given in the marginal information is the vertical distance between adjacent contour lines.

212. How can you determine the elevation of a point on the map?

   a. Determine the contour interval and the unit of measure used; for example, feet, meters, or yards (Figure 10-2). Find the numbered index contour line nearest the point you are trying to determine the elevation for (Figure 10-3). Determine if you are going from lower elevation to higher, or vice versa. In Figure 10-3, point (a) is between the index contour lines. The lower index contour line is numbered 500, which means any point on that line is at an elevation of 500 meters above mean sea level. The upper index contour line is numbered 600, or 600 meters. Going from the lower to the upper index contour line shows an increase in elevation.

   b. d. To determine the exact elevation of point (a), start at the index contour line numbered 500 and count the number of intermediate contour lines to point (a). Point (a) is located on the second intermediate contour line above the 500-meter index contour line. The contour interval is 20 meters (Figure 10-2), thus each intermediate contour line crossed to get to point (a) adds 20 meters to the 500-meter index contour line. The elevation of point (a) is 540 meters; the elevation has increased.

c. e. To determine the elevation of point (b), go to the nearest index contour line. In this case, it is the upper index contour line numbered 600. Point (b) is located on the intermediate contour line immediately below the 600-meter index contour line. Below means downhill or a lower elevation. Therefore, point (b) is located at an elevation of 580 meters. Remember, if you are increasing elevation, add the contour interval to the nearest index contour line. If you are decreasing elevation, subtract the contour interval from the nearest index contour line.

d. f. To determine the elevation to a hilltop, point (c), add one-half the contour interval to the elevation of the last contour line. In this example, the last contour line before the hilltop is an index contour line numbered 600. Add one-half the contour interval, 10 meters, to the index contour line. The elevation of the hilltop would be 610 meters.

213. A point located more than three-fourths of the distance between contour lines is considered to be at the same elevation as what contour line?

a. The next contour line.

214. How do you estimate the elevation to the bottom of a depression?

a. Subtract one-half the contour interval from the value of the lowest contour line before the depression. In Figure 10-5, the lowest contour line before the depression is 240 meters in elevation. Thus, the elevation at the edge of the depression is 240 meters. To determine the elevation at the bottom of the depression, subtract one-half the contour interval. The contour interval for this example is 20 meters. Subtract 10 meters from the lowest contour line immediately before the depression. The result is that the elevation at the bottom of the depression is 230 meters. The tick marks on the contour line forming a depression always point to lower elevations.

215. The rate of rise or fall of a terrain feature is known as what?

a. Depending on the military mission, Soldiers may need to determine not only the height of a hill, but the degree of the hill's slope as well. The speed at which equipment or personnel can move is affected by the slope of the ground or terrain feature. This slope can be determined from the map by studying the contour lines—the closer the contour lines, the steeper the slope; the farther apart the contour lines, the gentler the slope. Four types of slopes that concern the military are gentle, steep, concave, and convex.

216. How are gentle slopes depicted on contour lines?

a. Contour lines showing a uniform, gentle slope will be evenly spaced and wide apart (Figure 10-6, page 10-6). Considering relief only, a uniform, gentle slope allows the defender to use grazing fire. The attacking force has to climb a slight incline.

217. How are steep slopes depicted on contour lines?

a. Contour lines showing a uniform, steep slope on a map will be evenly spaced, but close together. Remember, the closer the contour lines, the steeper the slope

(Figure 10-7). Considering relief only, a uniform, steep slope allows the defender to use grazing fire, and the attacking force has to negotiate a steep incline.

218. How are concave slopes depicted on a map?
    a. Contour lines showing a concave slope on a map will be closely spaced at the top of the terrain feature and widely spaced at the bottom (Figure 10-8). Considering relief only, the defender at the top of the slope can observe the entire slope and the terrain at the bottom, but he cannot use grazing fire. The attacker would have no cover from the defender's observation of fire, and his climb would become more difficult as he gets farther up the slope.

219. How are convex slopes depicted on a map?
    a. Contour lines showing a convex slope on a map will be widely spaced at the top and closely spaced at the bottom (Figure 10-9). Considering relief only, the defender at the top of the convex slope can obtain a small distance of grazing fire, but he cannot observe most of the slope or the terrain at the bottom. The attacker will have concealment on most of the slope and an easier climb as he nears the top.

220. Slope may be expressed in several ways, but all depend upon the comparison of vertical distance (VD) to horizontal distance (HD) (Figure 10-10, page 10-8). What do we need in order to determine the percentage of a slope?
    a. Before we can determine the percentage of a slope, we must know the VD of the slope. The VD is determined by subtracting the lowest point of the slope from the highest point. Use the contour lines to determine the highest and lowest point of the slope (Figure 10-11).

221. All terrain features are derived from a complex landmass known as a mountain or ridgeline. What is a ridgeline?
    a. The term ridgeline is not interchangeable with the term ridge. A ridgeline is a line of high ground, usually with changes in elevation along its top and low ground on all sides from which a total of 10 natural or man-made terrain features are classified.

222. Major terrain features are:
    a. hills, saddles, valleys, ridges, and depressions.

223. What is a hill?
    a. A hill is an area of high ground. From a hilltop, the ground slopes down in all directions. A hill is shown on a map by contour lines forming concentric circles. The inside of the smallest closed circle is the hilltop (Figure 10-17).

224. What is a saddle?
    a. A saddle is a dip or low point between two areas of higher ground. A saddle is not necessarily the lower ground between two hilltops; it may be simply a dip or break along a level ridge crest. If you are in a saddle, there is high ground in two opposite directions and lower ground in the other two directions. A saddle is normally represented as an hourglass (Figure 10-18, page 10-12).

225. What is a valley?
    a. A valley is a stretched-out groove in the land, usually formed by streams or rivers. A valley begins with high ground on three sides and usually has a course

of running water through it. If standing in a valley, three directions offer high ground, while the fourth direction offers low ground. Depending on its size and where a person is standing, it may not be obvious that there is high ground in the third direction, but water flows from higher to lower ground. Contour lines forming a valley are either U-shaped or V-shaped. To determine the direction water is flowing, look at the contour lines. The closed end of the contour line (U or V) always points upstream or toward high ground (Figure 10-19).

226. What is a ridge?
    a. A ridge is a sloping line of high ground. If you are standing on the centerline of a ridge, you will normally have low ground in three directions and high ground in one direction with varying degrees of slope. If you cross a ridge at right angles, you will climb steeply to the crest and then descend steeply to the base. When you move along the path of the ridge, depending on the geographic location, there may be either an almost unnoticeable slope or a very obvious incline. Contour lines forming a ridge tend to be U-shaped or V-shaped. The closed end of the contour line points away from high ground (Figure 10-20).

227. What is a depression?
    a. A depression is a low point in the ground or a sinkhole. It could be described as an area of low ground surrounded by higher ground in all directions, or simply a hole in the ground. Usually only depressions that are equal to or greater than the contour interval will be shown. On maps, depressions are represented by closed contour lines that have tick marks pointing toward low ground (Figure 10-21).

228. What is a draw?
    a. A draw is a stream course that is less developed than a valley. In a draw, there is essentially no level ground and, therefore, little or no maneuver room within its confines. If you are standing in a draw, the ground slopes upward in three directions and downward in the other direction. A draw could be considered as the initial formation of a valley. The contour lines depicting a draw are U-shaped or V-shaped, pointing toward high ground.

229. What is a spur?
    a. A spur is a short, continuous sloping line of higher ground, normally jutting out from the side of a ridge. A spur is often formed by two roughly parallel streams cutting draws down the side of a ridge. The ground will slope down in three directions and up in one. Contour lines on a map depict a spur with the U or V pointing away from high ground (Figure 10-23).

230. What is a cliff?
    a. A cliff is a vertical or near vertical feature; it is an abrupt change of the land. When a slope is so steep that the contour lines converge into one "carrying" contour of contours, this last contour line has tick marks pointing toward low ground (A, Figure 10-24). Cliffs are also shown by contour lines very close together and, in some instances, touching each other (B, Figure 10-24).

231. What is a cut?

a. A cut is a man-made feature resulting from cutting through raised ground, usually to form a level bed for a road or railroad track. Cuts are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the cut line. This contour line extends the length of the cut and has tick marks that extend from the cut line to the roadbed, if the map scale permits this level of detail (Figure 10-25, page 10-16).

232. What is a fill?

a. A fill is a man-made feature resulting from filling a low area, usually to form a level bed for a road or railroad track. Fills are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the fill line. This contour line extends the length of the filled area and has tick marks that point toward lower ground. If the map scale permits, the length of the fill tick marks are drawn to scale and extend from the base line of the fill symbol (Figure 10-25).

233. Terrain features do not normally stand alone. What does this mean?

a. To better understand these when they are depicted on a map, you need to interpret them. You can interpret terrain features (Figure 10-26) by using contour lines; the shape, orientation, size, elevation, and slope (SOSES) approach; ridgelining; or streamlining.

234. A recommended technique for identifying specific terrain features and then locating them on the map is to use five characteristics known by the mnemonic SOSES. What does this mnemonic mean?

a. (1) Shape. Shape is the general form or outline of the feature at its base.

b. (2) Orientation. Orientation is the general trend or direction of a feature from your viewpoint. A feature can be in line, across, or at an angle to your viewpoint.

c. (3) Size. Size is the length or width of a feature horizontally across its base. For example, one terrain feature might be larger or smaller than another.

d. (4) Elevation. Elevation is the height of a terrain feature. This can be described either in absolute or relative terms as compared to the other features in the area. One landform may be higher, lower, deeper, or shallower than another.

e. (5) Slope. Slope is the type (uniform, convex, or concave) and steepness or angle (steep or gentle) of the sides of a terrain feature.

235. What is ridgelining?

a. This technique helps you to visualize the overall lay of the ground within the area of interest on the map. Use the following steps to implement this technique.

b. (1) Identify on the map the crests of the ridgelines in your area of operation by identifying the close-out contours that lie along the hilltop.

c. (2) Trace over the crests so each ridgeline stands out clearly as one identifiable line. The usual colors used for this tracing are red or brown; however, you may use any color at hand.

d. (3) Go back over each of the major ridgelines and trace over the prominent ridges and spurs that come out of the ridgelines.

e. (4) When you have completed the ridgeling process, you will find that the high ground on the map will stand out and that you will be able to see the relationship between the various ridgelines (Figure 10-27).

236. What is streamlining?

a. (1) Identify all the mapped streams in the area of operations.
b. (2) Trace over them to make them stand out more prominently. The color used for this is usually blue; but again, if blue is not available, use any color at hand so long as the distinction between the ridgelines and the streamlines is clear.
c. (3) Identify other low ground, such as smaller valleys or draws that feed into the major streams, and trace over them. This brings out the drainage pattern and low ground in the area of operation on the map.

237. The study of contour lines to determine high and low points of elevation is usually adequate for military operations. What is needed when the exact elevation of a specific point is required?

a. However, there may be times when a quick and precise reference to determine exact elevations of specific points is needed. When exactness is demanded, a profile is required. A profile, within the scope and purpose of this manual, is an exaggerated side view of a portion of the earth's surface along a line between two or more points.

238. A profile can be used for many purposes. The primary purpose is to determine if line of sight is available. What is line of sight used for?

a. • To determine defilade positions.
b. • To plot hidden areas or dead space.
c. • To determine potential direct fire weapon positions.
d. • To determine potential locations for defensive positions.
e. • To conduct preliminary planning in locating roads, pipelines, railroads, or other construction projects.

239. What are the steps for creating a profile from a contoured map?

a. (1) Draw a line on the map from where the profile is to begin to where it is to end. Find the value of the highest and lowest contour lines that cross or touch the profile line. Add one contour value above the highest and one below the lowest to take care of hills and valleys. Select a piece of lined notebook paper with as many lines as was determined in above. The standard Army green pocket notebook or any other paper with 1/4-inch lines is ideal. Wider lines, up to 5/8-inch, may be used. If lined paper is not available, draw equally spaced horizontal lines on a blank sheet of paper. Number the top line with the highest value and the bottom line with the lowest value as determined in (2) above. Number the rest of the lines in sequence, starting with the second line from the top. The lines will be numbered in accordance with the contour interval (Figure 10-29). Place the paper on the map with the lines next to and parallel to the profile line (Figure 10-29). From every point on the profile line where a contour line, stream, intermittent stream, or other body of water crosses or touches, drop a perpendicular line to the line having the same value. Place a tick mark where the perpendicular line crosses the number line. Where trees are present, add the height of the trees to the contour line and place a tick mark there. Assume the height of the trees to be 50 feet or 15 meters where dark green tint is shown on the map. Vegetation height may be adjusted up or down when operations in the area have provided known tree heights. After all perpendicular lines have been drawn and tick marks placed where the lines cross, connect all tick marks with a smooth, natural curve to form a horizontal view or profile of the terrain along the profile line (Figure 10-29).

240. What are considerations for orienting a map with a compass?

   a. When orienting a map with a compass, remember that the compass measures magnetic azimuths. Since the magnetic arrow points to magnetic north, pay special attention to the declination diagram. Two techniques are used.

241. How can you orient a map using the direction of the declination and its value from the declination diagram?

   a. (a) With the map in a horizontal position, take the straightedge on the left side of the compass and place it alongside the north-south grid line with the cover of the compass pointing toward the top of the map. This procedure places the fixed black index line of the compass parallel to north-south grid lines of the map. Keeping the compass aligned as directed above, rotate the map and compass together until the magnetic arrow is below the fixed black index line on the compass. At this time, the map is close to being oriented. Rotate the map and compass in the direction of the declination diagram. If the magnetic north arrow on the map is to the left of the grid north, check the compass reading to see if it equals the G-M angle given in the declination diagram. The map is then oriented (Figure 11-1, page 11-2). If the magnetic north is to the right of grid north, check the compass reading to see if it equals 360 degrees minus the G-M angle (Figure 11-2).

242. What is another technique for orienting a map using the direction of the declination and its value from the declination diagram?

   a. (a) Using any north-south grid line on the map as a base, draw a magnetic azimuth equal to the G-M angle given in the declination diagram with the protractor.
   b. (b) If the declination is easterly (right), the drawn line is equal to the value of the G-M angle. Then align the straightedge on the left side of the compass alongside the drawn line on
   c. the map. Rotate the map and compass until the magnetic arrow of the compass is below the fixed black index line. The map is now oriented (Figure 11-3).
   d. (c) If the declination is westerly (left), the drawn line will equal 360 degrees minus the value of the G-M angle. Then align the straightedge on the left side of the compass alongside
   e. the drawn line on the map. Rotate the map and compass until the magnetic arrow of the compass is below the fixed black index line. The map is now oriented (Figure 11-4).

243. How can you orient a map using Terrain Association?

   a. A map can be oriented by terrain association when a compass is not available or when the user has to make many quick references as he moves across country.

Using this method requires careful examination of the map and the ground, and the user must know his approximate location (Figure11-5).

244. What is the most important part of movement during land navigation?

a. Most important of all is the initial location of the user before starting any movement in the field. If movement takes place without establishing the initial location, everything that is done in the field from there on is a gamble. Determine the initial location by referring to the last known position, by grid coordinates and terrain association, or by locating and orienting your position on the map and ground.

245. Why is terrain association an effective method of movement?

a. The technique of moving by terrain association is more forgiving of mistakes and far less time-consuming than dead reckoning. It best suits those situations that call for movement from one area to another. Errors made using terrain association are easily corrected because you are comparing what you expected to see from the map to what you do see on the ground. Errors are anticipated and will not go unchecked. You can easily make adjustments based upon what you encounter. Periodic position-fixing through either plotted or estimated resection will also make it possible to correct your movements, call for fire, or call in the locations of enemy targets or any other information of tactical or logistical importance.

246. How can you match the terrain to the map by examining terrain features?

a. By observing the contour lines in detail, the five major terrain features (hilltop, valley, ridge, depression, and saddle) should be determined. This is a simple task in an area where the observer has ample view of the terrain in all directions. One-by-one, match the terrain features depicted on the map with the same features on the ground. In restricted terrain, this procedure becomes harder; however, constantly check the map as you move since it is the determining factor (Figure 11-5).

247. How can you compare the Vegetation Depicted on the Map to that of your environment?

a. When comparing the vegetation, a topographic map should be used to make a comparison of the clearings that appear on the map with the ones on the ground. The user must be familiar with the different symbols, such as vineyards, plantations, and orchards, that appear on the legend. The age of the map is an important factor when comparing vegetation. Some important vegetation features were likely to be different when the map was made. Another important factor about vegetation is that it can change overnight by natural accidents or by man (forest fires, clearing of land for new developments, farming, and so forth).

248. How does vegetation make terrain association difficult?

a. Camouflage the important landforms using vegetation.

b. Use of camouflage makes it harder for the navigator to use terrain association.

249. How can bodies of water help you in land navigation?
  a. Inland bodies of water can help during terrain association.
  b. The shape and size of lakes in conjunction with the size and direction of flow of the rivers and streams are valuable help.

250. How can man-made features help you navigate?
  a. Man-made features are an important factor during
  b. terrain association. The user must be familiar with the symbols shown in the legend representing those features. The direction of buildings, roads, bridges, high-tension lines, and so forth make the terrain inspection a lot easier; however, the age of the map must be considered because man-made features appear and disappear constantly.

251. Why is Examining the Same Piece of Terrain During the Different Seasons of the Year important?
  a. In those areas of the world where the seasons are distinctive, a detailed examination of the terrain should be made during each season. The same piece of land does not present the same characteristics during both spring and winter.

252. How does winter impact the terrain?
  a. During winter, the snow packs the vegetation, delineating the land, making the terrain features appear as clear as they are shown by the contour lines on the map. Ridges, valleys, and saddles are very distinctive.

253. During spring, the vegetation begins to reappear and grow. How does this change the shape of the landscape?
  a. New vegetation causes a gradual change of the land to the point that the foliage conceals the terrain features and makes the terrain hard to recognize. During summer months, the effects are similar to those in the spring.

254. Fall makes the land appear different with what changes to the environment?
  a. The change of color and gradual loss of vegetation.

255. How does the rain impact land?
  a. The vegetation is green and thick, and the streams and ponds look like small rivers and lakes. In sparsely vegetated areas, the erosion changes the shape of the land.

256. How does drought impact land?
  a. During a period of drought, the vegetation dries out and becomes vulnerable to forest fires that change the terrain whenever they occur. Also during this season, the water levels of streams and lakes drop, adding new dimensions and shape to the existing mapped areas.

257. Why is terrain important for OAKOC?
  a. terrain should be analyzed for observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach.

258. What does Observation and Fields of Fire refer to?
  a. The purpose of observation is to see the enemy (or various landmarks) but not be seen by him. Anything that can be seen can be hit. Therefore, a field of fire is

an area that a weapon or a group of weapons can cover effectively with fire from a given position.

259. What does Cover and Concealment refer to?

a. Cover is shelter or protection (from enemy fire) either natural or artificial. Always try to use covered routes and seek cover for each halt, no matter how brief it is planned to be. Unfortunately, two factors interfere with obtaining constant cover. One is time and the other is terrain. Concealment is protection from observation or surveillance, including concealment from enemy air observation. Before, trees provided good concealment, but with modern thermal and infrared imaging equipment, trees are not always effective. When you are moving, concealment is generally secondary; therefore, select routes and positions that do not allow covered or concealed enemy near you.

260. What does Obstacles refer to?

a. Obstacles are any obstructions that stop, delay, or divert movement. Obstacles can be natural (rivers, swamps, cliffs, or mountains) or they may be artificial (barbed wire entanglements, pits, concrete or metal antimechanized traps). They can be ready-made or constructed in the field. Always consider any possible obstacles along your movement route and, if possible, try to keep obstacles between the enemy and yourself.

261. What does Key Terrain refer to?

a. Key terrain is any locality or area that the seizure or retention of affords a marked advantage to either combatant. Urban areas are often seen by higher headquarters as being key terrain because they are used to control routes. On the other hand, an urban area that is destroyed may be an obstacle instead. High ground can be key because it dominates an area with good observation and fields of fire. In an open area, a draw or wadi (dry streambed located in an arid area) may provide the only cover for many kilometers, thereby becoming key. You should always attempt to locate any area near you that could be even remotely considered as key terrain.

262. What does Avenues of Approach refer to?

a. These are access routes. They may be the routes you can use to get to the enemy or the routes they can use to get to you. Basically, an identifiable route that approaches a position or location is an avenue of approach to that location. They are often terrain corridors such as valleys or wide, open areas.

263. How does METT-TC impact movement?

a. Tactical factors other than the military aspects of terrain must also be considered in conjunction with terrain during movement planning and execution as well. These additional considerations are mission, enemy, terrain and weather, troops, and time available.

264. What does Mission refer to?

a. This refers to the specific task assigned to a unit or individual. It is the duty or task together with the purpose that clearly indicates the action to be taken and the reason for it—but not how to do it. Training exercises should stress the importance of a thorough map reconnaissance to evaluate the terrain. This allows the leader to confirm his tentative plan, basing his decision on the terrain's effect on his mission.

265. What are marches used for?
    a. Marches by foot or vehicle are used to move troops from one location to another. Soldiers must get to the right place, at the right time, and in good fighting condition. The normal rate for an 8-hour foot march is 4 kilometers per hour. However, the rate of march may vary, depending on the following factors:
    b. • Distance.
    c. • Time allowed.
    d. • Likelihood of enemy contact.
    e. • Terrain.
    f. • Weather.
    g. • Physical condition of Soldiers.
    h. • Equipment/weight to be carried.

266. Patrol missions used to conduct what operations?
    a. Combat or reconnaissance operations. Without detailed planning and a thorough map reconnaissance, any patrol mission may not succeed. During the map reconnaissance, the mission leader determines a primary and alternate route to and from the objectives.

267. When is Movement to contact conducted?
    a. An element is moving toward the enemy but is not in contact with the enemy. The lead element must orient its movement on the objective by conducting a map reconnaissance, determining the location of the objective on both the map and the ground, and selecting the route to be taken.

268. Delays and withdrawals are conducted for what reason?
    a. Slow the enemy down without becoming decisively engaged, or to assume another mission. To be effective, the element leader must know where he is to move and the route to be taken.

269. What does the mission variable Enemy refer to?
    a. This refers to the strength, status of training, disposition (locations), doctrine, capabilities, equipment (including night vision devices), and probable courses of action that impact upon both the planning and execution of the mission, including a movement.

270. What does the mission variable Terrain and Weather refer to?
    a. Observation and fields of fire influence the placement of positions and crew-served weapons. The leader conducts a map reconnaissance to determine key terrain, obstacles, cover and concealment, and likely avenues of approach.

271. Key terrain is any area where:
    a. control affords a marked advantage to the force holding it. Some types of key terrain are high ground, bridges, towns, and road junctions.

272. Obstacles are natural or man-made terrain features that:
   a. stop, slow down, or divert movement. Consideration of obstacles is influenced by the unit's mission. An obstacle may be an advantage or disadvantage, depending upon the direction of attack or defense. Obstacles can be found by conducting a thorough map reconnaissance and study of recent aerial photographs.

273. Cover and concealment are determined for what forces?
   a. Both friendly and enemy forces. Concealment is protection from observation; cover is protection from the effects of fire. Most terrain features that offer cover also provide concealment from ground observation. There are areas that provide no concealment from enemy observation. These danger areas may be large or small open fields, roads, or streams. During the leader's map reconnaissance, he determines any obvious danger areas and, if possible, adjusts his route.

274. What are Avenues of approach (AAs)?
   a. Routes by which a unit may reach an objective or key terrain. To be considered an AA, a route must provide enough width for the deployment of the size force for which it is being considered. The AAs are also considered for the subordinate enemy force. For example, a company determines likely AAs for an enemy platoon; a platoon determines likely AAs for an enemy squad. Likely AAs may be either ridges, valleys, or by air. By examining the terrain, the leader determines the likely enemy AAs based on the tactical situation.

275. Weather has little effect on dismounted land navigation. Why is this?
   a. Rain and snow could possibly slow down the rate of march, that is all. But during mounted land navigation, the navigator must know the effect of weather on his vehicle. (See Chapter 12 for mounted land navigation.)

276. Why is it important to understand the capabilities of your own troops?
   a. Consideration of your own troops is equally important. The size and type of the unit to be moved and its capabilities, physical condition, status of training, and types of equipment assigned all affect the selection of routes, positions, fire plans, and the various decisions to be made during movement. On ideal terrain such as relatively level ground with little or no woods, a platoon can defend a front of up to 400 meters. The leader must conduct a thorough map reconnaissance and terrain analysis of the area his unit is to defend. Heavily wooded areas or very hilly areas may reduce the front a platoon can defend. The size of the unit must also be taken into consideration when planning a movement to contact. During movement, the unit must retain its ability to maneuver. A small draw or stream may reduce the unit's maneuverability but provide excellent concealment. All of these factors must be considered.

277. How are types of equipment that may be needed by the unit determined?
   a. by a map reconnaissance. For example, if the unit must cross a large stream during its movement to the objective, ropes may be needed for safety lines.

278. When must the physical capabilities of the Soldiers must be considered?

a. Selecting a route. Crossing a large swampy area may present no problem to a physically fit unit, but to a unit that has not been physically conditioned, the swampy area may slow or completely stop its movement.

279. Why is understanding time important for movement?

a. At times, the unit may have little time to reach an objective or to move from one point to another. The leader must conduct a map reconnaissance to determine the quickest route to the objective; this is not always a straight route. From point A to point B on the map may appear to be 1,000 meters, but if the route is across a large ridge, the distance will be greater. Another route from point A to B may be 1,500 meters—but on flat terrain. In this case, the quickest route would be across the flat terrain; however, concealment and cover may be lost.

280. What are examples of civil considerations for mission planning?

a. Civil considerations are present throughout offensive operations. They may preclude the attack of some targets, such as infrastructure and historically significant areas, and may limit the use of land mines.

281. Commanders focus their staffs on considerations that may affect mission accomplishment. What may these factors include?

a. These factors include care and support for civilians within the AO and the possible effect of refugees on operations and movements. Other considerations include enemy locations with respect to civil populations, political and cultural boundaries, and language requirements.

282. Enemy propaganda may affect the attitude of civilians in the AO. It may also affect domestic and foreign support for the operation. Why is this important to understand?

a. Operations commanders pay particular attention to the effects of actions in the information environment. Tactical commanders may have limited awareness of media reporting and its effect on public opinion. Operational commanders gauge the effect of public opinion and keep their subordinates informed.

283. One key to success in tactical missions is:

a. the ability to move undetected to the objective. There are four steps to land navigation. Being given an objective and the requirement to move there, you must know where you are, plan the route, stay on the route, and recognize the objective.

284. Know Where You Are (Step 1). You must know where you are on the map and on the ground at all times and in every possible way. This includes knowing where you are relative to what locations?

a. • Your directional orientation.
b. • The direction and distances to your objective.
c. • Other landmarks and features.
d. • Any impassable terrain, the enemy, and danger areas.
e. • Both the advantages and disadvantages presented by the terrain between you and your objective.

285. How do you figure out where you are?

a. Knowing how to read a map; recognize and identify specific terrain and other features; determine and estimate direction; pace, measure, and estimate distances; and both plot and estimate a position by resection.

286. Plan the Route (Step 2). Depending upon the size of the unit and the length and type of movement to be conducted, several factors should be considered in selecting a good route or routes to be followed. What factors determine route selection?

a. • Travel time.
b. • Travel distance.
c. • Maneuver room needed.
d. • Trafficability.
e. • Load-bearing capacities of the soil.
f. • Energy expenditure by troops.
g. • The factors of METT-TC.
h. • Tactical aspects of terrain (OCOKA).
i. • Ease of logistical support.
j. • Potential for surprising the enemy.
k. • Availability of control and coordination features.
l. • Availability of good checkpoints and steering marks.

287. Three route-selection criteria that are important for small-unit movements are:

a. cover, concealment, and the availability of reliable checkpoint features. The latter is weighted even more heavily when selecting the route for a night operation. The degree of visibility and ease of recognition (visual effect) are the key to the proper selection of these features.

288. What are good examples of reliable checkpoint features?

a. Examples include perennial streams, hard-top roads, ridges, valleys, railroads, and power transmission lines. Next, it is best to select features that represent elevation changes of at least two contour intervals such as hills, depressions, spurs, and draws. Primary reliance upon cultural features and vegetation is cautioned against because they are most likely to have changed since the map was last revised.

289. Checkpoints located at places where changes in direction are made mark what features?

a. decision points. Be especially alert to see and recognize these features during movement. During preparation and planning, it is especially important to review the route and anticipate where mistakes are most likely to be made so they can be avoided.

290. Following a valley floor or proceeding near (not on) the crest of a ridgeline generally offers what movement advantages?

a. easy movement, good navigation checkpoints, and sufficient cover and concealment. It is best to follow terrain features whenever you can—not to fight them.

291. A lost or a late arriving unit, or a tired unit that is tasked with an unnecessarily difficult move, does not contribute to the accomplishment of a mission. What is equally is bad?

a. On the other hand, the unit that moves too quickly and carelessly into a destructive ambush or leaves itself open to air strikes also has little effect. Careful planning and study are required each time a movement route is to be selected.

292. Why is it important to stay on your route?

a. In order to know that you are still on the correct route, you must be able to compare the evidence you encounter as you move according to the plan you developed on the map when you selected your route. This may include watching your compass reading (dead reckoning) or recognizing various checkpoints or landmarks from the map in their anticipated positions and sequences as you pass them (terrain association). A better way is to use a combination of both.

293. What does it mean to recognize your objective? What are ideal locations for movement objectives?

a. The destination is rarely a highly recognizable feature such as a dominant hilltop or road junction. Such locations as this are seldom missed by the most inexperienced navigators and are often dangerous places for Soldiers to occupy. The relatively small, obscure places are most likely to be the destinations.

294. Just how does a Soldier travel over unfamiliar terrain for moderate to great distances and know when he reaches the destination?

a. One minor error, when many are possible, can cause the target to be missed. Select a checkpoint (reasonably close to the destination) that is not so difficult to find or recognize. Then plan a short, fine-tuned last leg from the new expanded objective to the final destination. For example, you may be able to plan and execute the move as a series of sequenced movements from one checkpoint or landmark to another using both the terrain and a compass to keep you on the correct course. Finally, after arriving at the last checkpoint, you might follow a specific compass azimuth and pace off the relatively short, known distance to the final, pinpoint destination. This procedure is called point navigation. A short movement out from a unit position to an observation post or to a coordination point may also be accomplished in the same manner.

295. What are the steps for Moving by Dead Reckoning?

a. Dead reckoning consists of two fundamental steps. The first is the use of a protractor and graphic scales to determine the direction and distance from one point to another on a map. The second step is the use of a compass and some means of measuring distance to apply this information on the ground. In other words, it begins with the determination of a polar coordinate on a map and ends with the act of finding it on the ground. Dead reckoning along a given route is the application of the same process used by a mapmaker as he establishes a measured line of reference upon which to construct the framework of his map.

296. How can you determine locations through triangulation?

a. Therefore, triangulation exercises (either resection or intersection) can be easily undertaken by the navigator at any time to either determine or confirm precise locations along or near his route. Between these position-fixes, establish your location by measuring or estimating the distance traveled along the azimuth being followed from the previous known point. You might use pacing, a vehicle odometer, or the application of elapsed time for this purpose, depending upon the situation.

297. Most dead reckoned movements do not consist of single straight-line distances. Why is this?

a. You cannot ignore the tactical and navigational aspects of the terrain, enemy situation, natural and man-made obstacles, time, and safety factors. Another reason most dead reckoning movements are not single straight-line distances is because compasses and pace counts are imprecise measures. Error from them compounds over distance; therefore, you could soon be far from your intended route even if you performed the procedures correctly. The only way to counteract this phenomenon is to reconfirm your location by terrain association or resection. Routes planned for dead reckoning generally consist of a series of straight-line distances between several checkpoints with perhaps some travel running on or parallel to roads or trails.

298. There are two advantages to dead reckoning. What are they?

a. First, dead reckoning is easy to teach and to learn. Second, it can be a highly accurate way of moving from one point to another if done carefully over short distances, even where few external cues are present to guide the movements.

299. During daylight, across open country, along a specified magnetic azimuth, never walk with the compass in the open position and in front of you. Why is this?

a. Because the compass will not stay steady or level, it does not give an accurate reading when held or used this way. Begin at the start point and face with the compass in the proper direction, then sight in on a landmark that is located on the correct azimuth to be followed. Close the compass and proceed to that landmark. Repeat the process as many times as necessary to complete the straight-line segment of the route.

300. The landmarks selected for this purpose are called steering marks, and their selection is crucial to success in dead reckoning. How should steering marks be determined?

a. Steering marks should never be determined from a map study. They are selected as the march progresses and are commonly on or near the highest points visible along the azimuth line you are following when they are selected. They may be uniquely shaped trees, rocks, hilltops, posts, towers, and buildings—anything that can be easily identified. If you do not see a good steering mark to the front, you might use a back azimuth to some feature behind you until a good steering mark appears out in front.

301. What are the Characteristics of a good steering mark?

a. (a) It must have some characteristics about it, such as color, shade of color, size, or shape (preferably all four), that will assure you that it will continue to be recognized as you approach it.

b. (b) If several easily distinguished objects appear along your line of march, the best steering mark is the most distant object. This procedure enables you to travel farther with fewer references to the compass. If you have many options, select the highest object. A higher mark is not as easily lost to sight as is a lower mark that blends into the background as you approach it. A steering mark should be continuously visible as you move toward it.

c. (c) Steering marks selected at night must have even more unique shapes than those selected during daylight. As darkness approaches, colors disappear and objects appear as black or gray silhouettes. Instead of seeing shapes, you begin to see only the general outlines that may appear to change as you move and see the objects from slightly different angles.

d. Dead reckoning without natural steering marks is used when the area through which

e. you are traveling is devoid of features, or when visibility is poor. At night, it may be necessary to send a member of the unit out in front of your position to create your own steering mark in order to proceed. His position should be as far out as possible to reduce the number of chances for error as you move. Arm-and-hand signals or a radio may be used in placing him on the correct azimuth. After he has been properly located, move forward to his position and repeat the process until some steering marks can be identified or until you reach your objective.

302. (7) When handling obstacles/detours on the route, follow these guidelines:

a. (a) When an obstacle forces you to leave your original line of march and take up a

b. parallel one, always return to the original line as soon as the terrain or situation permits.

c. (b) To turn clockwise (right) 90 degrees, you must add 90 degrees to your original

d. azimuth. To turn counterclockwise (left) 90 degrees from your current direction, you must

e. subtract 90 degrees from your present azimuth.

f. (c) When making a detour, be certain that only paces taken toward the final destination

g. are counted as part of your forward progress. They should not be confused with the local

h. pacing that takes place perpendicular to the route in order to avoid the problem area and in returning to the original line of march after the obstacle has been passed.

303. Where can dead reckoning begin?

   a. Sometimes a steering mark on your azimuth of travel can be seen across a swamp or some other obstacle which you can simply walk around. Dead reckoning can then begin at that point. If there is no obvious steering mark to be seen across the obstacle, perhaps one can be located to the rear. Compute a back azimuth to this point and later sight back to it once the obstacle has been passed in order to get back on track. You can use the deliberate offset technique. Highly accurate distance estimates and precision compass work may not be required if the destination or an intermediate checkpoint is located on or near a large linear feature that runs nearly perpendicular to your direction of travel.Examples include roads or highways, railroads, power transmission lines, ridges, or streams. In these cases, you should apply a deliberate error (offset) of about 10 degrees to the azimuth you planned to follow and then move, using the lensatic compass as a guide, in that direction until you encounter the linear feature. You will know exactly which way to turn (left or right) to find your destination or checkpoint, depending upon which way you planned your deliberate offset.

304. How does dead reckoning help you correct navigation errors?

   a. Because no one can move along a given azimuth with absolute precision, it is better to plan a few extra steps than to begin an aimless search for the objective once you reach the linear feature. If you introduce your own mistake, you will certainly know how to correct it. This method will also cope with minor compass errors and the slight variations that always occur in the earth's magnetic field.

305. There are disadvantages to dead reckoning. The farther you travel by dead reckoning without confirming your position in relation to the terrain and other features, the more errors you will accumulate in your movements. How does this impact how you move?

   a. Therefore, you should confirm and correct your estimated position whenever you encounter a known feature on the ground that is also on the map. Periodically, you should accomplish a resection triangulation using two or more known points to pinpoint and correct your position on the map. Pace counts or any type of distance measurement should begin anew each time your position is confirmed on the map.

306. It is dangerous to select a single steering mark, such as a distant mountaintop, and then move blindly toward it. Why is this?

   a. What will you do if you must suddenly call for fire support or a medical evacuation? You must periodically use resection and terrain association techniques to pinpoint your location along the way.

307. Steering marks can be farther apart in open country, thereby making navigation more accurate. When must they be close together?

   a. In areas of dense vegetation, however, where there is little relief, during darkness, or in fog, your steering marks must be close together. This, of course, introduces more chance for error.

308. Dead reckoning is time-consuming and demands constant attention to the compass. What can complicate movement using dead reckoning?
    a. Errors accumulate easily and quickly. Every fold in the ground and detours as small as a single tree or boulder also complicate the measurement of distance.
309. What is more forgiving of mistakes and is less time consuming than dead reckoning?
    a. The technique of moving by terrain association is more forgiving of mistakes and far less time-consuming than dead reckoning. It best suits those situations that call for movement from one area to another. Once an error has been made in dead reckoning, you are off the track. Errors made using terrain association are easily corrected, however, because you are comparing what you expected to see from the map to what you do see on the ground.
310. Identifying and Locating Selected Features. Being able to identify and locate the selected features, both on the map and on the ground, are essential to the success in moving by terrain association. What rules can help you do this?
    a. (a) Be certain the map is properly oriented when moving along the route and use the terrain and other features as guides. The orientation of the map must match the terrain or it can cause confusion. To locate and identify features being used to guide the movement, look for the steepness and shape of the slopes, the relative elevations of the various features, and the directional orientations in relation to your position and to the position of the other features you can see. Make use of the additional cues provided by hydrography, culture, and vegetation. All the information you can gather will assist you in making the move. The ultimate test and the best practice for this movement technique is to go out in the field and use it. The use of terrain, other natural features, and any man-made objects that appear both on the map and on the ground must be practiced at every opportunity. There is no other way to learn or retain this skill. Using Handrails, Catching Features, and Navigational Attack Points. First, because it is difficult to dead reckon without error over long distances with your compass,the alert navigator can often gain assistance from the terrain.
311. What are handrails?
    a. roads or highways, railroads, power transmission lines, ridgelines, or streams that run roughly parallel to your direction of travel. Instead of using precision compass work, you can rough compass without the use of steering marks for as long as the feature travels with you on your right or left. It acts as a handrail to guide the way.
312. When you reach the point where either your route or the handrail changes direction, you must be aware that it is time to go your separate ways. What can help you find this point?
    a. Some prominent feature located near this point is selected to provide this warning. This is called a catching feature; it can also be used to tell you when you have gone too far.

313. Third, the catching feature may also be your navigational attack point; this point is the place where area navigation ends and point navigation begins. How are you supposed to move from this checkpoint?
   a. From this last easily identified checkpoint, the navigator moves cautiously and precisely along a given azimuth for a specified distance to locate the final objective. The selection of this navigational attack point is important. A distance of 500 meters or less is most desirable.

314. What are the Disadvantages of Terrain Association?
   a. The major disadvantage to navigation by terrain association is that you must be able to interpret the map and analyze the world around you. Recognition of terrain and other features, the ability to determine and estimate direction and distance, and knowing how to do quick in-the-head position fixing are skills that are more difficult to teach, learn, and retain than those required for dead reckoning.

315. How can a combination of dead reckoning and terrain association help you navigate effectively?
   a. Actually, the most successful navigation is obtained by combining the techniques described above. Constant orientation of the map and continuous observation of the terrain in conjunction with compass-read azimuths, and distance traveled on the ground compared with map distance, used together make reaching a destination more certain. One should not depend entirely on compass navigation or map navigation; either or both could be lost or destroyed.

316. Darkness presents its own characteristics for land navigation because of limited or no visibility. However, the techniques and principles are the same as those used for day navigation. What impacts your success in nighttime land navigation?
   a. The success in nighttime land navigation depends on rehearsals during the planning phase before the movement, such as detailed analysis of the map to determine the type of terrain in which the navigation is going to take place, and the predetermination of azimuths and distances. Night vision devices (Appendix G) can greatly enhance night navigation.

317. The basic technique used for nighttime land navigation is dead reckoning with several compasses recommended. How are several compasses to be used?
   a. The point man is in front of the navigator but just a few steps away for easy control of the azimuth. Smaller steps are taken during night navigation, so remember, the pace count is different. It is recommended that a pace count obtained by using a predetermined 100-meter pace course be used at night.

318. Navigation using the stars is recommended in some areas; however, a thorough knowledge of constellations and location of stars is needed. How can you use this during nighttime land navigation?
   a. The four cardinal directions can also be obtained at night using the same technique described for the shadow-tip method—just use the moon instead of the sun. In this case, the moon must be bright enough to cast a shadow.

319. The principles of land navigation while mounted are basically the same as while dismounted. What is the major difference?

   a. The major difference is the speed of travel. Walking between two points may take one hour, but riding the same distance may only take 15 minutes. To be effective at mounted land navigation, the travel speed must be considered. The duties of a navigator are so important and exacting that he should not be given any other duties. The leader should never try to be the navigator, since his normal responsibilities are heavy, and one or the other job would suffer.   a. Assembling Equipment. Before the mission starts, the navigator must gather all the equipment that will help him perform his job (maps, pencils, and so forth).
   b. b. Servicing Equipment. The navigator is responsible for making sure that all the equipment he may use or require is working.
   c. c. Recording Data for Precise Locations. During movement, the navigator must make sure that the correct direction and distance are recorded and followed. Grid coordinates of locations must be recorded and plotted. d. Supplying Data to Subordinate Leaders. During movement, any change in direction or distance must be given to the subordinate leaders in sufficient time to allow them to react. e. Maintaining Liaison with the Commander. The commander normally selects the route that he wants to use. The navigator is responsible for following that route; however, there may be times when the route must be changed during a tactical operation. For this reason, the navigator must maintain constant communication with the commander. The navigator must inform the commander when checkpoints are reached, when a change in direction of movement is required, and how much distance is traveled.

320. When preparing to move, what need to be determined?

   a. When preparing to move, the effects of terrain on navigating mounted vehicles must be determined. You will cover great distances very quickly, and you must develop the ability to estimate the distance you have traveled. Remember that 0.1 mile is roughly 160 meters, and 1 mile is about 1,600 meters or 1.6 kilometers. Having a mobility advantage helps while navigating. If you get disoriented, mobility makes it much easier to move to a point where you can reorient yourself.

321. When determining a route to be used when mounted, consider the capabilities of the vehicles to be used. What are vehicles limited by?

   a. Most military vehicles are limited in the degree of slope they can climb and the type of terrain they can negotiate. Swamps, thickly wooded areas, or deep streams may present no problems to dismounted Soldiers, but the same terrain may completely stop mounted Soldiers. The navigator must consider this when selecting a route.

322. Most vehicles can knock down a tree. The bigger the vehicle, the bigger the tree it can knock down. Why is this important to know?

   a. Vehicles cannot knock down several trees at once. It is best to find paths between trees that are wide enough for your vehicle. Military vehicles are designed to climb 60-percent slopes on a dry, firm surface (Figure 12-1).

323. How can you determine approximate slope?
   a. You can easily determine approximate slope by looking at the route you have selected on a map. A contour line in any 100 meters of map distance on that route indicates a 10-percent slope, two contour lines indicate 20-percent slope, and so forth. If there are four contour lines in any 100 meters, look for another route.
324. Side slope is even more important than the slope you can climb. Why is this?
   a. Normally, a 30-percent slope is the maximum in good weather. When traversing a side slope, progress slowly and without turns. Rocks, stumps, or sharp turns can cause you to throw the downhill track under the vehicle, which would mean a big recovery task.
325. How can weather impact movement?
   a. Weather can halt mounted movement. Snow and ice are obvious dangers, but more significant is the effect of rain and snow on the load-bearing ability of soil. Cross-country vehicles may be restricted to road movement in heavy rain. If it has rained recently, adjust your route to avoid flooded or muddy areas. A mired vehicle only hinders combat capability.
326. What is important to prepare before conducting any tactical movement?
   a. Locate the start point and finish point on the map. Determine the map's grid azimuth from start point to finish point and convert it to a magnetic azimuth. Determine the distance between the start point and finish point or any intermediate points on the map and make a thorough map reconnaissance of that area.
327. What are tactical aspects to consider while preparing for movement?
   a. Avoid skylining, select key terrain for overwatch positions, and select concealed routes.
328. Why is ease of movement important for route selection?
   a. Use the easiest possible route and bypass difficult terrain. Remember that a difficult route is harder to follow, is noisier, causes more wear and tear (and possible recovery problems), and takes more time. Tactical surprise is achieved by doing the unexpected. Try to select an axis or corridor instead of a specific route. Make sure you have enough maneuver room for the vehicles
329. What is important criteria for selecting natural features as movement checkpoints?
   a. These checkpoints must be easily recognizable in the light and weather conditions and at the speed at which you will move. You should be able to find a terrain feature from your location that can be recognized from almost anywhere and used as a guide. Movement and navigation along a valley floor or near (not necessarily on) the crest of a ridgeline is easiest.
330. What are good features to use as checkpoints?
   a. The next best checkpoints are elevation changes such as hills, depressions, spurs, and draws. Look for two contour lines of change. You will not be able to spot less than two lines of change while mounted.

331. How can you determine directions easier?

   a. Break the route down into smaller segments and determine the rough directions that will be followed. You do not need to use the compass; just use the main points of direction (north, northeast, east, and so forth). Before moving, note the location of the sun and locate north. Locate changes of direction, if any, at the checkpoints picked.

332. How can you determine distance of travel?

   a. Determine the total distance to be traveled and the approximate distance between checkpoints. Plan to use the vehicle odometer to keep track of distance traveled. Use the pace-count method and keep a record of the distance traveled. When using a pace count, convert from map distance to ground distance by adding the conversion factors of 20 percent for cross-country movement.

333. Can making mental notes help you navigate?

   a. Mental notes are usually adequate. Try to imagine what the route is like and remember it.

334. How can you plan to avoid errors?

   a. Restudy the route selected. Try to determine where errors are most apt to occur and how to avoid any trouble.

335. How can logbooks help you navigate?

   a. When the routes have been selected and the navigator has divided the distance to be traveled into legs, prepare a logbook. The logbook is an informal record of the distance and azimuth of each leg, with notes to aid the navigator in following the correct route. The notes list easily identifiable terrain features at or near the point where the direction of movement changes

336. What is dead reckoning in a vehicle?

   a. Dead reckoning is moving a set distance along a set line. Generally, it involves moving so many meters along a set line, usually an azimuth in degrees. There is no accurate method of determining a direction in a moving vehicle. A magnetic vehicle-heading reference unit may be available in a few years; for now, use a compass.

337. How do you navigate using Steering Marks during dead reckoning?

   a. This procedure is the same for vehicle travel as on foot.
   b. (1) The navigator dismounts from the vehicle and moves away from the vehicle (at least 18 meters).
   c. (2) He sets the azimuth on the compass and picks a steering mark (rock, tree, hilltop) in the direction on that azimuth (Figure 12-4).
   d. (3) He remounts and has the driver identify the steering mark and proceed to it in as straight a line as possible.
   e. (4) On arrival at the steering mark or on any changes in direction, the navigator repeats the first three steps for the next leg of travel.

338. How do you navigate using steering marks in a vehicle?

a. This procedure is used only on flat, featureless terrain. (1) The navigator dismounts from the vehicle, which is oriented in the direction of travel, and moves at least 18 meters to the front of the vehicle. (2) He faces the vehicle and reads the azimuth to the vehicle. By adding or subtracting 180 degrees, he determines the forward azimuth (direction of travel). (3) On order from the navigator, the driver drives on a straight line to the navigator. (4) The navigator remounts the vehicle, holds the compass as it will be held while the vehicle is moving, and reads the azimuth in the direction of travel. (5) The compass will swing off the azimuth determined and pick up a constant deviation. For example, the azimuth was 75 degrees while you were away from the vehicle. When you remounted and your driver drove straight forward, your compass showed 67 degrees. You have a deviation of -8 degrees. All you need to do is maintain that 67-degree compass heading to travel on a 75-degree magnetic heading. (6) At night, the same technique can be used. From the map, determine the azimuth you

b. are to travel. Convert the grid azimuth to a magnetic azimuth. Line the vehicle up on that azimuth, then move well in front of it. Be sure it is aligned correctly. Then mount, have the driver move slowly forward, and note the deviation. If the vehicle has a turret, the above procedure works unless you traverse the turret; this changes the deviation. (7) The distance factor in dead reckoning is easy. Just determine the map distance to travel and add 20 percent to convert to ground distance. Use your vehicle odometer to be sure you travel the proper distance.

339. What is stabilized turret alignment navigation?

a. Another method, if you have a vehicle with a stabilized turret, is to align the turret on the azimuth you wish to travel, then switch the turret stabilization system on. The gun tube remains pointed at your destination no matter which way you turn the vehicle. This technique has been proven; it works. It is not harmful to the stabilization system. It is subject to stabilization drift, so use it for no more than 5,000 meters before resetting.

340. Some mounted situations may call for you to combine and use both methods. Just remember the characteristics of each. What are they?

a. a. Terrain association is fast, is error-tolerant, and is best under most circumstances. It can be used day or night if you are proficient in it. b. Dead reckoning is very accurate if you do everything correctly. You must be very precise. It is also slow, but it works on very flat terrain. c. You frequently will combine both. You may use dead reckoning to travel across a large, flat area to a ridge, then use terrain association for the rest of the move. d. You must be able to use both methods. You should remember that your probable errors, in order of frequency, will be—

b. • Failure to determine distances to be traveled.

c. • Failure to travel the proper distance.

d. • Failure to properly plot or locate the objective.

e. • Failure to select easily recognized checkpoints or landmarks.

f. • Failure to consider the ease of movement factor.

341. How does desert terrain impact your navigation?

   a. About 5 percent of the earth's land surface is covered by deserts (Figure 13-1). Deserts are large arid areas with little or no rainfall during the year. There are three types of deserts—mountain, rocky plateau, and sandy or dune deserts. All types of forces can be deployed in the desert. Armor and mechanized infantry forces are especially suitable to desert combat except in rough mountainous terrain where light infantry may be required. Airborne, air assault, and motorized forces can also be advantageously employed to exploit the vast distances characteristic of desert warfare.

342. What terrain do you experience in deserts?

   a. In desert regions, terrain varies from nearly flat to lava beds and salt marshes. Mountain deserts contain scattered ranges or areas of barren hills or mountains.

343. Finding the way in a desert presents some degree of difficulty for a person who has never been exposed to this environment. Desert navigators have learned through generations of experience. What have desert navigators learned over time?

   a. Normally, desert people are nomadic, constantly moving in caravans. Navigating becomes second nature to them. Temperature in the tropical deserts reaches an average of 110 to 115 degrees during the day, so most navigation takes place at night using the stars. Most deserts have some prevailing winds during the seasons. Such winds arrange the sand dunes in a specific pattern that allows the navigator to determine the four cardinal directions. He may also use the sun's shadow-tip method.

344. How can you obtain a sense of direction in the desert?

   a. A sense of direction can be obtained by watching desert animals on their way to and from water holes (oases). Water, navigation, and survival are closely related in desert areas. Most deserts have pigeons or doves, and their drinking habits are important to the navigator. As a rule, these birds never drink in the morning or during the day, making their evening flights the most important. When returning from the oases, their bodies are heavier from drinking and their flight is accompanied by a louder flapping of their wings.

345. Cover can be provided only by terrain feature masking because of the lack of heavy vegetation and man-made objects. It only takes a few meters of relief to provide cover. Concealment in the desert is based from what factors?

   a. Cover vehicles so they and their shadows are not instantly recognizable. (b) Shine. Shine or glitter is often the first thing that attracts the observer's eye to movement many kilometers away. It must be eliminated. (c) Color and Texture. All equipment should either be pattern painted or mudded to blend in with the terrain. (d) Light and Noise. Light and noise discipline are essential because sound and light travel great distances in the desert. (e) Heat. Modern heat image technology makes shielding heat sources an important consideration when trying to hide from the enemy. This technology is especially important during night stops. Movement. Movement itself creates a great deal of noise and dust, but a rapid execution using all the advantages the topography offers can help conceal it.

346. Are terrain features available in desert environments?

a. When operating in the broad basins between mountain ranges or on rocky plateau deserts, there are frequently many terrain features to guide your movement. Observing these known features over great distances may provide a false sense of security in determining your precise location unless you frequently confirm your location by resection or referencing close-in terrain features. It is not uncommon to develop errors of several kilometers when casually estimating a position in this manner. Obviously, this can create many problems when attempting to locate a small checkpoint or objective, calling for combat support (CS), reporting operational or intelligence information, or meeting combat service support (CSS) requirements.

347. When operating in an area with few visual cues, such as a sandy or dune desert, or when visibility is restricted by a sandstorm or darkness, how do you navigate?

a. You must proceed by dead reckoning. The four steps and two techniques for navigation presented earlier remain valid in the desert. However, understanding the desert's special conditions is extremely helpful as you apply the techniques.

348. What are important for successful desert operations?

a. Tactical mobility and speed are key to successful desert operations. Obstacles and areas such as lava beds or salt marshes, which preclude surface movements, do exist. But most deserts permit two-dimensional movement by ground forces similar to that of a naval task force at sea. Speed of execution is essential. Everyone moves farther and faster on the desert.

349. Special navigation aids sometimes used in the desert include:

a. (a) Sun Compass. The sun compass can be used on moving vehicles and sextants. It requires accurate timekeeping. However, the deviation on a magnetic compass that is caused by the metal and electronics in the vehicle is usually less than +10 degrees. (b) Gyro Compass. The gun azimuth stabilizer is in fact a gyro compass. If used on fairly flat ground, it is useful for maintaining direction over limited distances. (c) Fires. Planned tracer fire or mortar and artillery concentrations (preferably smoke during the day and illumination at night) provide useful checks on estimated locations. (d) Pre-positioned Lights. This method consists of placing two or more searchlights far apart, behind the line of contact, beyond enemy artillery range, and concealed from enemy ground observation. Units in the area can determine their own locations through resection, using the vertical beams of the lights. These lights must be moved on a time schedule known to all friendly units. (3) The sand, hard-baked ground, rocky surfaces, thorny vegetation, and heat generally found in the desert impose far greater demands for maintenance than you would plan for in temperate regions. It may also take longer to perform that maintenance.

350. Mountains are generally understood to be larger than hills. Rarely do mountains occur individually; in most cases, they are found in elongated ranges or circular groups. What are linked mountains called?

   a. When they are linked together, they constitute a mountain system (Figure 13-2). Light forces (infantry, airborne, and air assault forces) can operate effectively in mountainous regions because they are not limited by terrain. Heavy forces must operate in passes and valleys that are negotiable by vehicle.

351. What are mountain systems characterized by?

   a. Mountain systems are characterized by high, inaccessible peaks and steep slopes. Depending on the altitude, they may be snow covered. Prominent ridges and large valleys are also found. Navigating in this type of terrain is not difficult providing you make a careful examination of the map and the terrain.

352. What are the major mountain systems?

   a. Andes Central and South America
   b. Rockies North America (USA and Canada)
   c. Appalachians North America (USA and Canada)
   d. Alps Central Europe
   e. Himalayas Asia
   f. Caucasus Western Asia and Europe (Russia)

353. Some minor mountain systems are located in:

   a. Antarctica, Hawaii, Japan, New Zealand, and Oceania.

354. What are the climates associated with mountain systems?

   a. Because of the elevations, it is always colder (3 to 5 degrees per 300-meter gain in altitude) and wetter than you might expect. Wind speeds can increase the effects of the cold even more. Sudden severe storms and fog are encountered regularly. Below the tree line, vegetation is heavy because of the extra rainfall and the fact that the land is rarely cleared for farming.

355. What are considerations for operations in mountainous terrain?

   a. The heights of mountainous terrain permit excellent long-range observation. However, rapidly fluctuating weather with frequent periods of high winds, rain, snow, or fog may limit visibility. Also, the rugged nature of the terrain frequently produces significant dead space at mid ranges.

356. Reduced mobility, compartmented terrain, and the effects of rapidly changing weather increase the importance of:

   a. air, ground, aerial photo, and map reconnaissance. Since mountain maps often use large contour intervals, microrelief interpretation and detailed terrain analysis require special emphasis.

357. At first glance, some mountainous terrain may not appear to offer adequate cover and concealment; however, you can improve the situation. How so?

   a. When moving, use rock outcroppings, boulders, and heavy vegetation for cover and concealment; use terrain features to mask maneuvers. Use harsh weather, which often obscures observation, to enhance concealment.

358. Since there are only a few routing options, what is of primary concern?
    a. all-round security must be of primary concern. Natural obstacles are everywhere, and the enemy can easily construct more.
359. What offer the best routes for movement in mountainous terrain?
    a. Existing roads and trails offer the best routes for movement. Off-road movement may enhance security provided there is detailed reconnaissance, photo intelligence, or information from local inhabitants to ensure the route is negotiable. Again, the four steps and two techniques for navigation presented earlier remain valid in the mountains. Nevertheless, understanding the special conditions and the terrain will help you navigate.
360. How do you determine aspect of slope?
    a. To determine the aspect of slope, take a compass reading along an imaginary line that runs straight down the slope. It should cut through each of the contour lines at about a 90-degree angle. By checking the map and knowing the direction of slope where you are located, you will be able to keep track of your location, and it will help guide your cross-country movement even when visibility is poor.
361. What are considerations for use of an altimeter?
    a. Employment of an altimeter with calibrations on the scale down to 10 or 20 meters is helpful to land navigators moving in areas where radical changes in elevation exist. An altimeter is a type of barometer that gauges air pressure, except it measures on an adjustable scale marked in feet or meters of elevation rather than in inches or centimeters of mercury. Careful use of the altimeter helps to pinpoint your position on a map through a unique type of resection. Instead of finding your position by using two different directional values, you use one directional value and one elevation value.
362. What are the characterizations of jungles?
    a. These large geographic regions are found within the tropics near the equator (Central America, along the Amazon River, South-Eastern Asia and adjacent islands, and vast areas in the middle of Africa and India) Jungles are characterized as rainy, humid areas with heavy layers of tangled, impenetrable vegetation. Jungles contain many species of wildlife (tigers, monkeys, parrots, snakes, alligators, and so forth). The jungle is also a paradise for insects, which are the worst enemy of the navigator because some insects carry diseases (malaria, yellow fever, cholera, and so forth). While navigating in these areas, very little terrain association can be accomplished because of the heavy foliage. Dead reckoning is one of the methods used in these areas. A lost navigator in the jungle can eventually find his way back to civilization by following any body of water with a downstream flow. However, not every civilization found is of a friendly nature.

363. How can jungle environment impact operations?

  a. Operations in jungles tend to be isolated actions by small forces because of the difficulties encountered in moving and in maintaining contact between units. Divisions can move cross-country slowly; but, aggressive reconnaissance, meticulous intelligence collection, and detailed coordination are required to concentrate forces in this way. More commonly, large forces operate along roads or natural avenues of movement, as was the case in the mountains. Patrolling and other surveillance operations are especially important to ensure security of larger forces in the close terrain of jungles.

364. Short fields of observation and fire and thick vegetation make maintaining contact with the enemy difficult. How does this impact combat effectiveness?

  a. The same factors reduce the effectiveness of indirect fire and make jungle combat primarily a fight between infantry forces. Support by air and mechanized forces can be decisive at times, but it will not always be available or effective.

365. What are jungle climates like?

  a. Jungles are characterized by high temperatures, heavy rains, high humidity, and an abundance of vegetation. The climate varies with location. Close to the equator, all seasons are nearly alike with heavy rains all year. Farther from the equator (India and Southeast Asia), there are distinct wet (monsoon) and dry seasons. Both zones have high temperatures (averaging 75 to 95+ degrees Fahrenheit), heavy rainfall (as much as 400+ inches annually), and high humidity (90 percent) all year.

366. In temperate climates, areas of vegetation are the most likely to be altered and incorrectly portrayed on a map. Why is this?

  a. In jungle areas, the vegetation grows so rapidly that it is more likely to be cleared and make these areas be shown incorrectly.

367. What are components of the jungle environment?

  a. The jungle environment includes dense forests, grasslands, swamps, and cultivated areas. Forests are classified as primary and secondary based upon the terrain and vegetation. Primary forests include tropical rain forests and deciduous forests. Secondary forests are found at the edges of both rain forests and deciduous forests and in areas where jungles have been cleared and abandoned. These places are typically overgrown with weeds, grasses, thorns, ferns, canes, and shrubs. Movement is especially slow and difficult. The extremely thick vegetation reaches a height of 2 meters and severely limits observation to only a few meters.

368. What are tropical rain forests made of?

  a. Tropical rain forests consist mostly of large trees whose branches spread and lock together to form canopies. These canopies, which can exist at two and three different levels, may form as low as 10 meters from the ground. They prevent direct sunlight from reaching the ground, causing a lack of undergrowth on the jungle floor. Extensive above-ground root systems and hanging vines are common and make vehicular travel difficult; foot movement is easier. Ground observation is limited to about 50 meters and air observation is nearly impossible.

369. What are deciduous forests?

a. Deciduous forests are in semitropical zones that have both wet and dry seasons. In the wet season, trees are fully leafed; in the dry season, much of the foliage dies. Trees are usually less dense than in rain forests, which allows more sunlight to filter to the ground and produces thick undergrowth. During the wet season, air and ground observation is limited and movement is difficult. During the dry season, both improve.

370. What are considerations for navigating in swamps?

a. Swamps are common to all low, jungle areas where there is poor drainage. When navigating in a swampy area, a careful analysis of map and ground should be taken before any movement. The Soldiers should travel in small numbers with only the equipment required for their mission, keeping in mind that they are going to be immersed in water part of the time. The usual technique used in swamp navigation is dead reckoning. There are two basic types of swamps—mangrove and palm. Mangrove swamps are found in coastal areas wherever tides influence water flow. Mangrove is a shrub-like tree that grows 1 to 5 meters high. These trees have a tangled root system, both above and below the waterline, which restricts movement either by foot or small boat. Observation on the ground and from the air is poor, but concealment is excellent.

371. What are considerations for navigating in savannahs?

a. Grassy plains or savannas are generally located away from the equator but within the tropics. These vast land areas are characterized by flatlands with a different type of vegetation than jungles. They consist mainly of grasses (ranging from 1 to more than 12 feet in height), shrubs, and isolated trees. The most difficult areas to navigate are the ones surrounded by tall grass (elephant grass); however, vehicles can negotiate here better than in some areas. There are few or no natural features to navigate by, making dead reckoning or navigation by stars the only technique for movement. Depending on the height of the grass, ground observation may vary from poor to good. Concealment from air observation is poor for both Soldiers and vehicles.

372. Bamboo stands are common throughout the tropics. What are tips for navigating in them?

a. They should be bypassed whenever possible. They are formidable obstacles for vehicles, and Soldier movement through them is slow, exhausting, and noisy.

373. Cultivated areas exist in jungles also. What are the three types of cultivated areas?

a. They range from large, well-planned, well-managed farms and plantations to small tracts cultivated by farmers. The three general types of cultivated areas are rice paddies, plantations, and small farms.

374. Why is it difficult to map jungles?
   a. Areas such as jungles are generally not accurately mapped because heavy vegetation makes aerial surveys difficult. The ability to observe terrain features, near or far, is extremely limited. The navigator must rely heavily upon his compass and the dead reckoning technique when moving in the jungle. Navigation is further complicated by the inability to make straight-line movements. Terrain analysis, constant use of the compass, and an accurate pace count are essential to navigation in this environment.

375. Rates of movement and pace counts are particularly important to jungle navigators. Why is this?
   a. The most common error is to overestimate the distance traveled. The distances in Table 13-3 can be used as a rough guide for the maximum distances that might be traveled in various types of terrain during one hour in daylight.

376. What is arctic terrain?
   a. Arctic terrain includes those areas that experience extended periods of below freezing temperatures. In these areas, the ground is generally covered with ice or snow during the winter season. Although frozen ground and ice can improve trafficability, a deep accumulation of snow can reduce it. Vehicles and personnel require special equipment and care under these adverse conditions.

377. What are considerations for movement in arctic terrain?
   a. Both the terrain and the type and size of unit operations vary greatly in arctic areas. In open terrain, armored and mechanized forces will be effective although they will have to plan and train for the special conditions. In broken terrain, forests, and mountains, light forces will predominate as usual. However, foot movement may take up to five times as long as it might under warmer conditions.

378. What are the terrain features commonly seen in arctic terrain?
   a. Both the terrain and cultural features you may confront in winter may vary to any extreme, as can the weather. The common factor is an extended period of below freezing temperatures. The terrain may be plains, plateaus, hills, or mountains. The climate will be cold, but the weather will vary greatly from place to place. Although most arctic terrain experiences snow, some claim impressive accumulations each season such as the lake-effected snow belts off Lake Ontario near Fort Drum, New York. Other areas have many cold days with sunshine and clear nights, and little snow accumulation.

379. What can help movement in arctic terrain?
   a. In areas with distinct local relief and scattered trees or forests, the absence of foliage makes movement by terrain association easier; observation and fields of fire are greatly enhanced except during snowstorms. In relatively flat, open areas covered with snow (especially in bright sunlight), the resulting lack of contrast may interfere with your being able to read the land. With foliage gone, concealment (both from the ground and from the air) is greatly reduced. As in desert areas, you must make better use of the terrain to conceal your movements.

380. What special skills may be required in arctic terrain?

a. Proper use of winter clothing, skis, and snowshoes; but this does not affect your navigation strategies. There are no special techniques for navigating in arctic terrain. Just be aware of the advantages and disadvantages that may present themselves and make the most of your opportunities while applying the four steps and two techniques for land navigation. Remember, the highest caliber of leadership is required to ensure that all necessary tasks are performed, that security is maintained, and that Soldiers and their equipment are protected from the physical effects of very low temperatures. There is a great temptation to do less than a thorough job at whatever the task may be when you are very cold. Night navigation may be particularly enhanced when operating in arctic terrain. Moonlight and starlight on a clear night reflect off the snow, thus enabling you to employ daytime terrain association techniques with little difficulty. Even cloudy winter nights are often brighter than clear moonlit summer nights when the ground is dark and covered with foliage. Movements with complete light discipline (no blackout drives) can often be executed. On the other hand, areas with severe winter climates experience lengthy periods of darkness each day, which may be accompanied by snow and limited visibility.

381. How does urban terrain impact navigation?

a. Military operations on urbanized terrain require detailed planning that provides for decentralized execution. As a result of the rapid growth and changes occurring in many urban areas, the military topographic map is likely to be outdated. Supplemental use of commercially-produced city maps may be helpful, or an up-to-date sketch can be made. Urbanized terrain normally offers many AAs for mounted maneuver well forward of and leading to urban centers. In the proximity of these built-up areas, however, such approach routes generally become choked by urban sprawl and perhaps by the nature of adjacent natural terrain. Dismounted forces then make the most of available cover by moving through buildings and underground systems, along edges of streets, and over rooftops. Urban areas tend to separate and isolate units, requiring the small-unit leader to take the initiative and demonstrate his skill in order to prevail.

382. How does urban terrain impact movement?

a. The urban condition of an area creates many obstacles, and the destruction of many buildings and bridges as combat power is applied during a battle further limits your freedom of movement. Cover and concealment are plentiful, but observation and fields of fire are greatly restricted. Navigation in urban areas can be confusing, but there are often many

383. cues that will present themselves as you proceed. What do they include?

a. They include streets and street signs; building styles and sizes; the urban geography of industrial, warehousing, residential housing, and market districts; man-made transportation features other than streets and roads and the terrain features and hydrographic features located within the built-up area. Use the following strategies to stay on the route in an urban area.

384. What helps you build Conceptual Understanding of the Urban Area?
   a. While studying the map and operating in a built-up area, work hard to develop an understanding (mental map) of the entire area. This advantage will allow you to navigate over multiple routes to any location. It will also preclude your getting lost whenever you miss a turn or are forced off the planned route by obstacles or the tactical situation.
385. How can you use resection in an urban setting?
   a. Whenever you have a vantage point to two or more known features portrayed on the map, do not hesitate to use either estimated or plotted resection to pinpoint your position. These opportunities are often plentiful in an urban setting.
386. How can a sketch help you navigate in urban terrain?
   a. is a free-hand drawing of a map or picture of an area or route of travel. It shows enough detail and has enough accuracy to satisfy special tactical or administrative requirements.
387. When are sketches useful in urban terrain?
   a. Sketches are useful when maps are not available or the existing maps are not adequate, or to illustrate a reconnaissance or patrol report. Sketches may vary from hasty to complete and detailed, depending upon their purpose and the degree of accuracy required. For example, a sketch of a large minefield will require more accuracy than a hasty sketch of a small unit's defensive position.
388. Field Sketches. A field sketch (Figure A-1) must show the north arrow, a scale, a legend, and the following features:
   a. • Power lines.
   b. • Rivers.
   c. • Main roads.
   d. • Towns and villages.
   e. • Forests.
   f. • Rail lines.
   g. • Major terrain features.
389. What do road sketches show?
   a. Road sketches show the natural and military features on and in the immediate vicinity of the road. In general, the width of terrain sketches will not exceed 365 meters on each side of the road. Road sketches may be used to illustrate a road when the existing map does not show sufficient detail.
390. What are area sketches?
   a. Area sketches include sketches of positions, OPs, or particular places.
391. What is a position sketch?
   a. A position sketch is one of a military position, campsite, or other area of ground. To effectively complete a position sketch, the sketcher must have access to all parts of the area being sketched.
392. What is an observation post sketch?
   a. An OP sketch shows the military features of ground along a friendly OP line as far toward the enemy position as possible.

393. What is a place sketch?

   a. A place sketch is one of an area made by a sketcher from a single point of observation. Such a sketch may cover ground in front of an OP line, or it may serve to extend a position or road sketch toward the enemy.

394. The basic topographic information is the same on both JOG versions. What are the basic topographic portions of urban maps?

   a. Power transmission lines are symbolized as a series of purple pylons connected by a solid purple line. Airports, landing facilities, and related air information are shown in purple. The purple symbols that may be unfamiliar to the user are shown in the legend in the margin. The top of each obstruction to air navigation is identified by its elevation above sea level and its elevation above ground level. Along the north and east edges of the graphic, detail is extended beyond the standard sheet lines to create an overlap with the graphics to the north and to the east. Layer tinting and relief shading are added as an aid to interpreting the relief. The incidence of the graphic in the world geographic reference system is shown by a diagram in the margin. The JOG (AIR) series, prepared for air use, contains detailed information on air facilities such as radio ranges, runway lengths, and landing surfaces.The highest terrain elevation in each 15-minute quadrangle is identified by the large open-faced figures shown in the legend. Elevations and contours on JOG (AIR) sheets are given in feet.

395. What is the joint operations graphics series

   a. The JOG (GROUND) series is prepared for use by ground units, and only stable or permanent air facilities are identified. Elevations and contours are located in the same positions as on the air version, but are given in meters.

396. What comprises the compass body assembly?

   a. This assembly consists of a nonmagnetic body and a circular glass window that covers the instrument, and keeps dust and moisture from its interior, protecting the compass needle and angle-of-site mechanism. A hinge assembly holds the compass cover in the position in which it is placed. A hole in the cover coincides with a small oval window in the mirror on the inside of the cover. A sighting line is etched across the face of the mirror.

397. What is the angle-of-site mechanism? What is it made of?

   a. The angle-of-site mechanism is attached to the bottom of the compass body. It consists of an actuating (leveling) lever located on the back of the compass, a leveling assembly with a tubular elevation level, and a circular level. The instrument is leveled with the circular level to read azimuths and with the elevation level to read angles of site. The elevation (angle-of-site) scale and the four points of the compass, represented by three letters and a star, are engraved on the inside bottom of the compass body. The elevation scale is graduated in two directions; in each direction it is graduated from 0 to 1200 mils in 20-mil increments and numbered every 200 mils.

398. How does the Magnetic Needle and Lifting Mechanism work?
   a. The magnetic needle assembly consists of a magnetized needle and a jewel housing that serves as a pivot. The north-seeking end of the needle is white. (The newer compasses have the north and south ends of the needle marked "N" and "S" in raised, white lettering.) On some compasses a thin piece of copper wire is wrapped around the needle for counterbalance. A lifting pin projects above the top rim of the compass body. The lower end of the pin engages the needle-lifting lever. When the cover is closed, the magnetic needle is automatically lifted from its pivot and held firmly against the window of the compass.

399. What is the azimuth scale?
   a. The azimuth scale is a circular dial geared to the azimuth scale adjuster. This permits rotation of the azimuth scale about 900 mils in either direction. The azimuth index provides a means of orienting the azimuth scale at 0 or the declination constant of the locality. The azimuth scale is graduated from 0 to 6400 in 20-mil increments and numbered at 200-mil intervals.

400. What are the Front and Rear Sights for the compass?
   a. The front sight is hinged to the compass cover. It can be folded across the compass body, and the cover closed. The rear sight is made in two parts—a rear sight and a holder. When the compass is not being used, the rear sight and holder are folded across the compass body and the cover is closed.

401. What is the M2 compass?
   a. The M2 compass is a rustproof and dustproof magnetic instrument that provides slope, angle of site, and azimuth readings. One of the most important features of the M2 compass is that it is graduated in mils and does not require a conversion from degrees to mils as does the M1 compass. It can be calibrated to provide a grid azimuth or it can be used without calibration to determine a magnetic azimuth. The M2 compass is a multiple-purpose instrument used primarily to obtain azimuths and angles of site. It also measures grid azimuths after the instrument has been declinated for the locality.

402. How do you properly use your compass?
   a. The compass should be held as steadily as possible to obtain accurate readings. The use of a sitting or prone position, a rest for the hand or elbows, or a solid nonmetallic support helps eliminate unintentional movement of the instrument. When being used to measure azimuths, the compass must not be near metallic objects. Zero the azimuth scale by turning the scale adjuster. Place the cover at an angle of about 45 degrees to the face of the compass so that the scale reflection is viewed in the mirror. Adjust the front and rear sights to the desired position. Sight the compass by any of these methods: Raise the front sight and the extended rear sight assembly perpendicular to the face of the compass. Sight over the tips of the front and rear sights. If the object is above the line of sighting, fold the rear sight toward the eye as needed. The instrument is correctly aligned when, with the level centered, the operator sees the tips of the sights and the center of the object at the same time. Raise the rear sight approximately

perpendicular to the face of the compass. Sight on the object through the opening in the rear sight holder and through the window in the cover. Keep the compass level and raise or lower the eye along the opening in the rear sight holder until the black center line of the window bisects the object and the opening in the rear sight holder. Fold the rear sight holder out parallel with the face of the compass with the rear sight perpendicular to its holder. Sight through or over the rear sight and view the object through the window in the cover. If the object sighted is at a lower elevation than the compass, raise the rear sight holder as needed. The compass is correctly sighted when the compass is level and the operator sees the black center line of the window bisecting the rear sight and the object sighted.

403. What is the enhanced Position Location Reporting System (EPLRS)/Joint Tactical Information Distribution System (JTIDS)?

a. The enhanced Position Location Reporting System (EPLRS)/Joint Tactical Information
b. Distribution System (JTIDS) hybrid (PJH) is a computer-based system. It provides near real-time, secure data communications, identification, navigation, position location, and automatic reporting to support the need of commanders for information on the location, identification, and movement of friendly forces. The EPLRS is based on synchronized radio transmissions in a network of users controlled by a master station. The major elements of an EPLRS community include the airborne, surface vehicular, and man-pack users; the EPLRS master station; and an alternate master station. The system can handle 370 user units in a division-size deployment per master station with a typical location accuracy at 15 meters. The man-pack unit weighs 23 pounds and includes the basic user unit, user readout, antenna, backpack, and two batteries.

404. The EPLRS is deployed at battalion and company level. What does its use allow?

a. Infantry or tank platoons to locate their positions, know the location of their friendly units, navigate to predetermined locations, and be informed when near or crossing boundaries. Artillery batteries to locate forward observers and friendly units, and position firing batteries. Aircraft to locate their exact positions; know the location of other friendly units; navigate to any friendly units, or a location entered by the pilot; navigate in selected flight corridors; and be alerted when entering or leaving corridors or boundaries. Command and control elements at all echelons to locate and control friendly units/aircraft. The network control station is located at brigade level to provide position location/ navigation and identification services. It also provides interface between the battalion and company systems, and the JTIDS terminals. The EPLRS is fielded to infantry, armor, field artillery, military police, engineer, intelligence, aviation, signal, and air defense artillery units. The EPLRS is a system that allows units to navigate from one point to another with the capability of locating itself and other friendly units equipped with the same system.

405. What is GPS?

  a. The GPS is a space-based, radio-positioning navigation system that provides accurate passive position, speed, distance, and bearing of other locations to suitably equipped users. The system assists the user in performing such missions as siting, surveying, tactical reconnaissance, sensor emplacement, artillery forward observing, close air support, general navigation, mechanized maneuver, engineer surveying, amphibious operations, signal intelligence operations, electronic warfare operations, and ground-based forward air control. It can be operated in all weather, day or night, anywhere in the world; it may also be used during nuclear, biological, and chemical warfare. It has been widely fielded in both active and reserve component units.

406. What is PADS?
  a. The PADS is a highly mobile, self-contained, passive, all-weather, survey-accurate position/navigation instrument used by field artillery and air defense artillery units for fire support missions. Its basis of issue is two sets per artillery battalion. The device is about the size of a 3-kilowatt generator and weighs 322.8 pounds in operational configuration. The two-man PADS survey party uses the HMMWV, the commercial utility cargo vehicle, the small-unit support vehicle, or the M151 1/4-ton utility truck. The system can be transferred while operating into the light observation helicopter (OH-58A) or driven into the CH-47 medium cargo helicopter. The system provides real-time, three-dimensional coordinates in meters and a grid azimuth in mils. It also gives direction and altitude. The PADS can be used by the land navigator to assist in giving accurate azimuth and distance between locations. A unit requiring accurate information as to its present location can also use PADS to get it. The PADS, if used properly, can assist many units in the performance of their mission.

407. What is the G/VLLD?
  a. The G/VLLD is the Army's long-range designator for precision-guided semi-active laser weapons. It is two-man portable for short distances and can be mounted on the M113A1 interim FIST vehicle when it has the vehicle adapter assembly. The G/VLLD provides accurate observer-to-target distance, vertical angle, and azimuth data to the operator. All three items of information are visible in the operator's eyepiece display. After discussing the many difficulties and limited advantages encountered when using foreign maps, it is only appropriate that some strategy be offered to help you with the task.

408. In the August 1942 issue of The Military Engineer, Robert B. Rigg, Lieutenant, Cavalry, suggested a five-step process for reading and interpreting foreign maps. What is it?

  a. Look for the date of the map first. There are generally four dates: survey and compilation, publication, printing and reprinting, and revision. The date of the survey and compilation is most important. A conspicuous date of revision generally means that the entire map was not redrawn—only spot revisions were made. Step 2. Note whether the publisher is military, government, or civilian. Maps published by the government or the military are generally most accurate. Step 3. Look at the composition. To a great extent, this will reveal the map's accuracy. Was care taken in the cartography? Are symbols and labels properly placed? Is the draftsmanship precise? Is the coastline or river bank detailed? Step 4. Observe the map's color. Does it enhance your understanding or does it obscure and confuse? The importance of one subject (coloring) must warrant canceling others. If it confuses, the map is probably not very accurate. Step 5. Begin to decode the various map colors, symbols, and terms. Study these items by examining one feature classification at a time (culture, hydrography, topography, and vegetation). As an accomplished navigator, you should already have a good understanding of your area of operations, so translation of the map's symbols should not present an impossible task. Use your notebook to develop an English version of the legend or create a new legend of your own.

409. The GPS is a satellite-based, radio navigational system. What is it comprised of?

  a. It consists of a constellation with 24 active satellites that interfaces with a ground-, air-, or sea-based receiver. Each satellite transmits data that enables the GPS receiver to provide precise position and time to the user. The GPS receivers come in several configurations; hand-held, vehicular-mounted, aircraft-mounted, and watercraft-mounted.

410. What is the GPS based on?

  a. The GPS is based on satellite ranging. It figures the user's position on earth by measuring the distance from a group of satellites in space to the user's location. For accurate three-dimensional data, the receiver must track four or more satellites. Most GPS receivers provide the user with the number of satellites that it is tracking, and whether or not the signals are good. Some receivers can be manually switched to track only three satellites if the user knows his altitude. This method provides the user with accurate data much faster than that provided by tracking four or more satellites. Each type receiver has a number of mode keys that have a variety of functions. To better understand how the GPS receiver operates, refer to the operator's manual.

411. The GPS provides worldwide, 24-hour, all-weather, day or night coverage when the satellite constellation is complete. The GPS can locate the position of the user accurately to within 21 meters—95 percent of the time. How does it determine your location?

   a. However, the GPS has been known to accurately locate the position of the user within 8 to 10 meters. It can determine the distance and direction from the user to a programmed location or the distance between two programmed locations called way points. It provides exact date and time for the time zone in which the user is located.

412. The data supplied by the GPS is helpful in performing several techniques, procedures, and missions that require soldiers to know their exact location. Some examples are:

   a. • Sighting.
   b. • Surveying.
   c. • Sensor or minefield emplacement.
   d. • Forward observing.
   e. • Close air support.
   f. • Route planning and execution.
   g. • Amphibious operations.
   h. • Artillery and mortar emplacement.
   i. • Fire support planning.

413. What are the limitations of GPS?

   a. A constellation of 24 satellites broadcasts precise signals for use by navigational sets. The satellites are arranged in six rings that orbit the earth twice each day. The GPS navigational signals are similar to light rays, so anything that blocks the light will reduce or block the effectiveness of the signals. The more unobstructed the view of the sky, the better the system performs.

414. All GPS receivers have primarily the same function, but the input and control keys vary between the different receivers. The GPS can reference and format position coordinates in what systems?

   a. • Degrees, Minutes, Seconds (DMS): Latitude/longitude-based system with position expressed in degrees, minutes, and seconds.
   b. • Degrees, Minutes (DM): Latitude/longitude-based system with position expressed in degrees and minutes.
   c. • Universal Traverse Mercator (UTM): Grid zone system with the northing and easting position expressed in meters.
   d. • Military Grid Reference System (MGRS): Grid zone/grid square system with coordinates of position expressed in meters.

415. How do GPS systems determine coordinates?

   a. GPS makes determining a 4-, 6-, 8-, and 10-digit grid coordinate of a location easy. On most GPS receivers, the position mode will give the user a 10-digit grid coordinate to their present location.

416. How do you determine distance and direction using GPS?

a. The mode for determining distance and direction depends on the GPS receiver being used. One thing the different types of receivers have in common is that to determine direction and distance, the user must enter at least one way point (WPT). When the receiver measures direction and distance from the present location or from way point to way point, the distance is measured in straight line only. Distance can be measured in miles, yards, feet, kilometers, meters, or nautical knots or feet. For determining direction, the user can select degrees, mils, or rads. Depending on the receiver, the user can select true north, magnetic north, or grid north.

417. How does Navigational Equipment and Methods work when using a GPS?

a. Unlike the compass, the GPS receiver when set on navigation mode (NAV) will guide the user to a selected way point by actually telling the user how far left or right the user has drifted from the desired azimuth. With this option, the user can take the most expeditious route possible, moving around an obstacle or area without replotting and reorienting.

418. How does GPS impact Mounted Land Navigation?

a. While in the NAV mode, the user can navigate to a way point using steering and distance, and the receiver will tell the user how far he has yet to travel, and at the current speed, how long it will take to get to the way point.

419. How does the AN/PSN-11?

a. The AN/PSN-11 is designed for battlefield use anywhere in the world. It is sealed watertight for all-weather day or night operation. The AN/PSN-11 is held in the left hand and operated with the thumb of the left hand. Capability is included for installation in ground facilities, and air, sea, and land vehicles. The AN/PSN-11 is operated stand-alone using prime battery power and integral antenna. It can be used with external power source and external antenna.

420. The AN/PSN-11 provides the user with position coordinates, time, and navigation information under all conditions, if—

a. • No obstructions block the line-of-sight satellite signal from reaching the antenna.

b. • Valid crypto keys are used to protect the AN/PSN-11 from intentionally degraded satellite signals. Many data fields, such as elevation, display units of information. The format of the units can be changed to your most familiar format. Map coordinates are entered as a waypoint. When a waypoint is selected as a destination, the AN/PSN-11 provides steering indications, azimuth, and range information to the destination. A desired course to a waypoint is entered. Offset distance from this course line is shown. Up to 999 waypoints can be entered, stored, and selected as a destination. A route is defined for navigation either start-to-end or end-to-start. The route consists of up to nine legs (ten waypoints) linked together.

421. Data provided by the AN/PVS-11 helps complete missions such as:
  a. • Siting.
  b. • Surveying.
  c. • Tactical reconnaissance.
  d. • Sensor emplacement.
  e. • Artillery forward observing.
  f. • Close air support.
  g. • General navigation.
  h. • Mechanized maneuvers.
  i. • Engineer surveying.
  j. • Amphibious operations.
  k. • Parachute operations.
  l. • Signal intelligence.
  m. • Electronic warfare.
  n. • Ground-based forward air control.

422. What are the specifications of the AN/PSN-11?
  a. less than 9.5 inches long, 4.1 inches wide, and 2.6 inches deep. It weighs 2.75 pounds with all batteries in place. The small size and light weight make the set easy to carry and use. The durable plastic case is sealed for all-weather use. The AN/PSN-11 features make it easy to use.

423. Setting up the operation parameters of the AN/PSN-11 is critical. This section describes the display and the procedures and principles used in setting the display to suit the needs of the user. This display consists of seven pages that allows the user to control what parameters?
  a. • Operating mode.
  b. • Type of satellites to use.
  c. • Coordinate system.
  d. • Units.
  e. • Magnetic variation.
  f. • Display customization.
  g. • Navigation Display mode.
  h. • Elevation hold mode.
  i. • Time and error formats.
  j. • Datum.
  k. • Automatic off timer.
  l. • Datum port configuration.
  m. • AutoMark mode.

424. What is the DAGR's primary function?
  a. navigate through terrain using stored waypoint position information. The DAGR is also used in operations such as waypoint calculations, data transfer, targeting, determining jamming sources, gun laying, and man overboard.

425. The DAGR is primarily a:

   a. handheld unit with a built-in integral antenna, but can be installed in a host platform (ground facilities; air, sea, and land vehicles) using an external power source and an external antenna (Figure K-1, page K-2). The DAGR used as a handheld unit can also operate with an external L1/L2 antenna and a source of external power. Table K-1 describes some of its characteristics and capabilities.

426. What are parts of marginal information?

   a. Top center: sheet name
   b. Top left corner: geographic location of the map and scale of the map.
   c. Top right corner: contains the map edition, map series, and the map sheet number.
   d. Bottom Left corner: Legend, map sheet number, and map sheet name
   e. Bottom Center: bar scales in meters, yards, miles, and nautical miles; contour interval; grid reference box, declination diagram, and G-M angle (mils or degrees).
   f. Lower Right Corner: elevation guide, adjoining map sheet diagram, and boundaries box (shows boundaries on the map)

427. What are the three base lines?

   a. True North
   b. Grid North
   c. Magnetic North

428. Where is the sheet name found?

   a. The sheet name is found in bold print at the center of the top and in the lower left area of the map margin. A map is generally named for the settlement contained within the area covered by the sheet, or for the largest natural feature located within the area at the time the map was drawn.

429. Where is the sheet number found?

   a. The sheet number is found in bold print in both the upper right and lower left areas of the margin, and in the center box of the adjoining sheets diagram, which is found in the lower right margin. It is used as a reference number to link specific maps to overlays, operations orders, and plans. For maps at 1:100,000 scale and larger, sheet numbers are based on an arbitrary system that makes possible the ready orientation of maps at scales of 1:100,000, 1:50,000, and 1:25,000.

430. Where is the map series found?

   a. It is found in the upper left corner of the margin. The name given to the series is generally that of a major political subdivision, such as a state within the United States or a European nation. A map series usually includes a group of similar maps at the same scale and on the same sheet lines or format designed to cover a particular geographic area. It may also be a group of maps that serve a common purpose, such as the military city maps.

431. Where is map scale found?

   a. The scale note is a representative fraction that gives the ratio of a map distance to the corresponding distance on the earth's surface. For example, the scale note 1:50,000 indicates that one unit of measure on the map equals 50,000 units of the same measure on the ground

432. Where is the declination diagrams found?

   a. This is located in the lower margin of large-scale maps and indicates the angular relationships of true north, grid north, and magnetic north. On maps at 1:250,000 scale, this information is expressed as a note in the lower margin. In recent edition maps, there is a note indicating the conversion of azimuths from grid to magnetic and from magnetic to grid next to the declination diagram. the division line between the series.

433. Where are bar scales found?

   a. These are located in the center of the lower margin. They are rulers used to convert map distance to ground distance. Maps have three or more bar scales, each in a different unit of measure. Care should be exercised when using the scales, especially in the selection of the unit of measure that is needed.

434. Where is the grid reference box found?

   a. This box is normally located in the center of the lower margin. It contains instructions for composing a grid reference

435. Where is the contour interval note found? What is it used for?

   a. Center of the lower margin normally below the bar scales? It states the vertical distance between adjacent contour lines of the map. When supplementary contours are used, the interval is indicated. In recent edition maps, the contour interval is given in meters instead of feet.

436. Where is the map legend located?

   a. Lower left margin. It illustrates and identifies the topographic symbols used to depict some of the more prominent features on the map. The symbols are not always the same on every map. Always refer to the legend to avoid errors when reading a map.

437. What are the five basic colors on a map? What does each color signify?

   a. BLACK: Indicates cultural (man-made) features such as buildings and roads, surveyed spot elevations, and all labels.
   b. BLUE: Identifies hydrographic or water features such as lakes, swamps, rivers, and drainage.
   c. GREEN: Identifies vegetation with military significance, such as woods, orchards, and vineyards.
   d. BROWN Identifies all relief features and elevation, such as contours on older edition maps, and cultivated land on red-light readable maps.
   e. RED: Classifies cultural features, such as populated areas, main roads, and boundaries, on older maps

438. Where are the five major terrain features?

a. Hill: a point or small area of high ground from which the ground slopes down in all directions. On a map the contour lines form concentric circles.
b. Valley: reasonably level ground bordered on the sides by higher ground.
c. Generally has maneuver room. Contains a stream. On the map the contour lines form a U. Lines tend to parallel stream before crossing. Contour line crossing a stream always points upstream.
d. Saddle: a dip or low point along a ridge crest; either lower ground between two hilltops or break in the level crest.
e. On the map a saddle is normally represented as an hourglass.
f. Depression: a low point or hole in the ground with higher ground on all sides.
g. On the map a depression is represented by closed contour lines that have tick marks pointing toward low ground.
h. Ridge: a sloping line of high ground.

439. What are the three minor terrain features?

a. Draw: like a valley but normally has less developed stream course. No level ground and little or no maneuver room. Ground slopes upward on the sides and toward the head of the draw. On the map a draw is represented by V-shaped contour lines with the point of the V toward the head of the draw (high ground).
b. Spur: a short continuously sloping line of higher ground jutting out the side of a ridge. Often formed by parallel streams cutting draws down a ridge. Contour lines depict a spur with the U or V pointing away from high ground.
c. Cliff: a vertical or near vertical feature, it is an abrupt change of the land. When a slope is so steep that the contour lines converge into one 'carrying' contour of contours, this last contour line has tick marks pointing toward low ground. Cliffs are also shown by contour lines very close together, and in some instances touching.

440. What are the supplementary terrain features?

a. Cut: a man-made feature resulting from cutting through raised ground, usually to form a level bed for a road or railroad track. Cuts are shown on a map when they are at least 10 feet deep, and they are drawn with a contour line along the cut. This contour line extends along the length of the cut and has tick marks that extend from the cut line to the roadbed.
b. Fill:a man-made feature resulting from filling a low area, usually to form a bed for a road or railroad track. Fills are shown on a map when they are at least 10 feet high, and they are drawn with a contour line along the filled area and has tick marks that point toward lower ground.

441. What is the method for finding your grid?

a. Line up your vertical and horizontal scale lines with the desired grid square Slide the protractor from right to left until the vertical scale is over your point. Were the horizontal scale meets your left grid square line gives you your first set of grid digits. Where your vertical scale meets your point gives you your second set of grid digits.

442. How do you determine grid azimuth on a military map?
   a. Draw a straight line between the two points connecting them (A to B) Using a straight edge connect the two points. Place the center of the protractor on A. Keep the center crosshair lines on the protractor parallel with the horizontal and vertical grid lines on the map. Follow the drawn line from point A to where it intersects with one of the numbers representing degrees on the outside of the protractor. If it is not directly on a tick mark, select the closest mark. This is the grid azimuth from point A to point B.

443. How does the declination diagram help you convert grid azimuths to magnetic azimuths?
   a. If the magnetic arrow on the declination diagram is to the right of the North grid arrow you add the GM angle to the magnetic azimuth to convert magnetic to grid. Subtract to convert grid to magnetic. If the magnetic arrow is on the left side of the North grid arrow you must subtract the GM angle to convert magnetic to grid and add to convert grid to magnetic.

444. How do you Determine the elevation to a hilltop point?
   a. Add one-half the contour interval to the elevation of the last contour line.

445. How do you estimate the elevation to the bottom of a depression?
   a. Subtract one-half the contour interval from the value of the lowest contour line before the depression. Bench marks symbolized by a black X, such as X BM 214. The 214 indicates that the center of the X is at an elevation of 214 units of measure (feet, meters, or yards) above mean sea level. To determine the units of measure, refer to the contour interval in the marginal information.

446. What are supplementary features?
   a. These contour lines resemble dashes. They show changes in elevation of at least one-half the contour interval. These lines are normally found where there is very little change in elevation, such as on fairly level terrain.

447. The basic rule to plotting a point on a map to determine a grid coordinate is?
   a. always read right and up.

448. What is intersection?
   a. Location of unknown points by occupying at least two (preferably three) known positions on the ground and then map sighting on the unknown location. It is used to locate distant or inaccessible points or objects such as enemy targets and danger areas.

449. What are the 7 Steps of doing a Intersection?
   a. Orient the map using the compass. Locate and mark your position on the map. Determine the magnetic azimuth to the unknown position using the compass.

Convert the magnetic azimuth to grid azimuth. Draw a line on the map from your position on this grid azimuth. Move to a second known point and repeat steps 1, 2, 3, 4, and 5. The location of the unknown position is where the lines cross on the map. Determine the grid coordinates to the desired accuracy.

450. What is a resection?
    a. Resection is the method of locating one's position on a map by determining the grid azimuth to at least two well-defined locations that can be pinpointed on the map. For greater accuracy, the desired method of resection would be to use three or more well-defined locations

451. What are the 9 steps for performing a resection?
    a. Choose a distinctive, distant feature such as a hilltop or bend in a river. Use your compass to determine the exact magnetic direction from your location to the feature you chose. Convert from magnetic to grid. Place the center point of your protractor on the map, in the location of the feature you've chosen. Line up the 0-degree point of your protractor on a line running from map north to map south. Make a mark next to your protractor at the degrees of the "Back Azimuth" of what you calculated map direction. Draw a line using a straightedge along the line indicated by your work with the protractor. Repeat the process with a second landmark. Double-check your calculations, adjusting the lines if necessary. Your location is where the two lines intersect on the map.

452. What is the center hold method for taking a target azimuth bearing?
    a. Open the cover until it forms a straight edge with the base, place your thumb through the thumb loop, form a steady base and turn your entire body toward the object pointing the compass cover directly at the object. Once you are pointing at the object, look down and read the azimuth from the fixed black index line. The center-hold technique is less precise, but is faster to use and can be used under all conditions of visibility.

453. What is Dead Reckoning?
    a. Dead reckoning is the technique of traveling a set distance along a set azimuth. ("Move 500 meters on an azimuth of 225 degrees.") Dead reckoning has two advantages. First, it's easy to teach and to learn. Second, in most cases it will be your primary method of navigating during hours of limited visibility.

454. Terrain association is movement using landmarks as guides. What are advantages of this technique?
    a. This technique is more forgiving of pace or azimuth mistakes you make during dead reckoning. with practice can be far less time-consuming than dead

reckoning. When navigating by terrain association, you continuously identify terrain features on the map with those on the ground while using handrails and catching features. You can become disoriented or even lost, however, if you fail to keep your map oriented in your direction of travel. In dead reckoning, once you make an error, you're off the track. When you make an error using terrain association, however, you can easily correct it because you are constantly comparing what you see on the map with what you actually see on the ground.

455. How do you calculate the straight-line distance between two points on your map?

a. Lay a straight-edged piece of paper on the map so the edge of your paper touches both points and extends past them.
b. 2. Make a tick mark on the edge of the paper at each point.
c. 3. Then move your paper to the graphic bar scale, and use the scale to measure the distance between the two points.

456. To measure the distance along a curved route, such as a road, trail, waterway, or other curved line:

a. Put a straight-edged piece of paper on your map with the edge next to your starting point. Place a tick mark on the paper and on your map. Line up the straight edge of the paper with the straight portion of the curved route you are measuring. Make a tick mark on both map and paper when the edge of the paper leaves the straight portion of the line you're measuring. Pivot the paper until another straight portion of the curved line lines up with the edge of the paper. Continue in this manner until you have completed the distance you want to measure.