ARMY
EXTENSION COURSE

AVIATION SUBCOURSE 75
MAP READING

PROGRAM 1
INTRODUCTION AND TERMS

UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA
MAY 1966

INTRODUCTION

Do you know what a map is? A map is a drawing of all or part of the earth's surface. It shows political boundaries, bodies of water, mountains, cities, roads, and other natural and manmade features. The drawing is usually made on a flat surface and is drawn to scale. The natural and manmade features are shown by symbols, lines, colors, and forms. A photograph is not a map. A photograph is a pictured reproduction. A globe is not a map. A globe is a small model.

Why are maps important to you? If you are to be an Army aviator, you must learn to read a military map. A map, when used correctly, can give accurate information on distances, locations, heights, key terrain features, best routes, concealment, and cover. Operations of the U. S. Army today may take you into any part of the world. Much of the planning for these operations is done on maps. And, most important, when you yourself are in a strange area, your map will quickly become your most prized guide - if you can read it!

Military maps are identified according to scale; that is, according to a ratio of map distance to ground distance. The map may be small scale, medium scale, or large scale. These terms (small, medium, and large scale) may be confusing when read in numbers. For example, a map at scale 1:600,000 is a small-scale map, while 1:75,000 describes a large-scale map. These numbers must be thought of as fractions. Then you realize that 1 to 600,000 of something is smaller than 1 to 75,000 of the same thing. Remember, then, the larger the number after 1:, the smaller the scale of the map. Maps at scales of 1:600,000 and smaller are small-scale maps. Maps at scales larger than 1:600,000, but smaller than 1:75,000, are medium-scale maps. Maps at scales of 1:75,000 and larger are large-scale maps.

This Map Reading Subcourse* covers the high points of the most used and more difficult phases of map reading. It contains seven separate self-tutor programs and an examination. Programmed instruction is a relatively new text method and is being used more and more

*Adapted from the "Self-Tutor Map Reading Refresher Course," SSTS 60004, of the U. S. Army Signal Center and School.

for self-instruction. These programs give you bits (frames) of information. Then you are asked to answer questions about each bit of information by filling in blanks. Immediately upon turning the page you are able to check yourself - to see if you answered correctly. Thus, you test yourself as you go along. Then after you complete all seven programs, you take the examination, which covers the material in the entire subcourse. Appendix II of this program introduces you to the self-tutor instruction method.

Each program (lesson) of the subcourse can be finished as a separate unit, and should take you about 60 minutes or less to complete. Thus, you can work the programs into your daily schedule of activity without taking up too much of your time.

Included in this first program (as appendix I) is a glossary to help you understand some of the new terms you will meet while studying map reading. Glance over them now. Then as you go through the other programs of this subcourse, you may need to refer back to this glossary to be sure you understand certain of these terms.

Note. For this reason, be sure you keep this first program, and keep it in a convenient place.

Remember, you are not expected to learn everything you read in this first lesson of the subcourse. You probably won't remember very many of the definitions included in the glossary. However, from this subcourse, you will learn some of the many interesting facts about map reading. Then, later in your training, when you are studying map reading in detail, you will find that study easier.

Included in this subcourse are the following separate programs (7):

a. Introduction. This program (1) introduces you to map reading, gives you a list of reference terms and definitions to be used throughout this course, and illustrates the programmed or self-tutor method of instruction.

b. Military Symbols. This program (2) shows you the symbols used to designate troop units, observation posts, and combat service support elements. It explains how the symbols are combined to identify specific units, such as 2d Platoon, Company C, 40th Airborne Signal Battalion.

c. Military Grid Reference System. This program (3) teaches you how to read grid coordinates (lines) on a map. When you learn how to do this, you will be able to pinpoint specific features or landmarks on a map by referencing their grid location.

d. Directions. This program (4) teaches you how to determine directions by using a base line as reference. You will also learn how to measure angles (azimuths and back azimuths).

e. Orienting a Map. This program (5) will teach you how to orient a map - that is, when you are using your map, how to align the top of the map with north so that the surrounding terrain features will appear in the same relative positions and distances as they appear on the map.

f. Contours and Profiles. In this program (6) you will learn about contour lines (those showing elevation and relief). You will also learn how profiles are drawn to show the side view of terrain features.

g. Slope. This program (7) will teach you about the rate of rise or fall of a ground form - steep slopes, gentle slopes, and methods of determining the degree of slope.

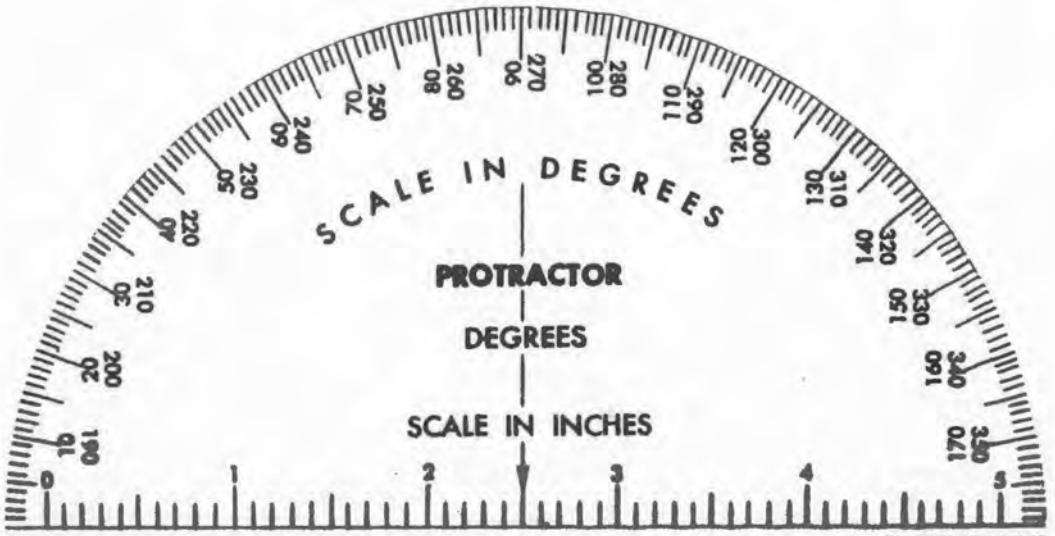
Note. Whenever you need an instrument such as a protractor or a compass to complete a program, it will be noted at the end of the introduction to the program. The following materials are also furnished:

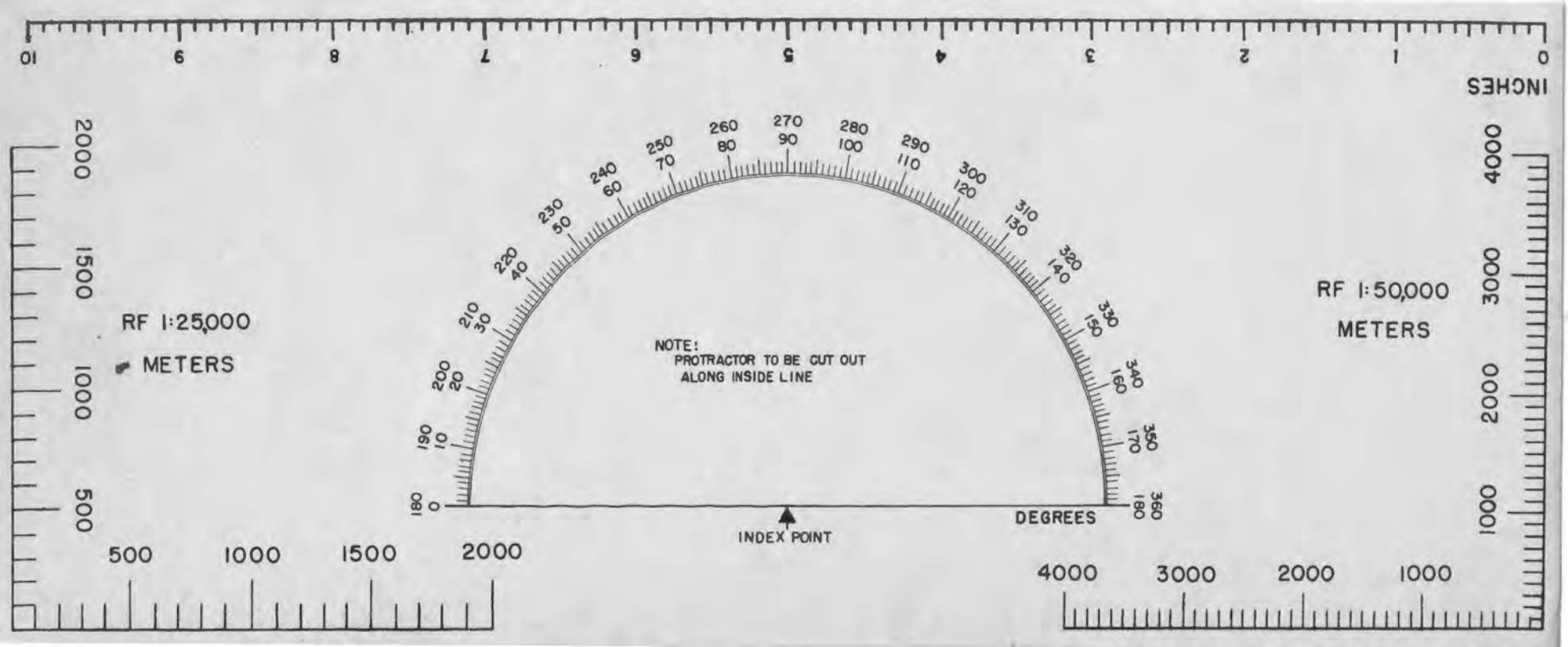
a. Map, Mineral Wells, Texas, 1:50,000, Sheet 6349 I.

b. Map, Weatherford, Texas, 1:50,000, Sheet 6449 IV.

c. Protractor.

d. 3x5 card.


SCALE IN DEGREES
PROTRACTOR
DEGREES
SCALE IN INCHES
FT RUCKER 125213


INCHES
RF 1:25,000
METERS
RF 1:50,000
METERS
NOTE:
PROTRACTOR TO BE CUT OUT
ALONG INSIDE LINE
INDEX POINT
DEGREES

ENGINEER SCALE

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

CENTIMETERS

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

APPENDIX I

GLOSSARY

arc - A portion of a curved line, as of a circle.

arms and services - This term includes the different branches of the Army. Arms include those branches whose primary mission is combat and combat support, such as artillery and infantry. Services include those branches whose primary mission is to provide combat service support and/or administration to the Army, such as medical service units.

army group - Two or more field armies under a designated commander; primarily a tactical command.

azimuth - The horizontal angle measured in a clockwise manner from a base line to the line of sight on an object. Azimuths are a means of expressing direction.

back azimuth - The reverse of an azimuth.

base line - To measure anything, there must always be a starting point or zero measurement. Likewise, to express a direction as a unit of angular measure, there must be a starting point or zero measure. This zero measure is known as a base line or reference line. There are three base lines: true north, magnetic north, and grid north. (Those most commonly used are magnetic north and grid north; magnetic north when working with a compass, grid north when working with a military map.)

battalion - Unit composed of a headquarters and two or more companies or batteries; equivalent to a squadron.

battery - Tactical and administrative artillery unit or subunit; equivalent to a company.

bearing - The horizontal angle measured in an east or west direction from a north or south base line. Bearings, like azimuths, are a means of expressing direction.

bench mark - A symbol, usually an X, used to indicate points of known elevation. The elevation is given beside the X. Bench marks indicate spot elevations on a map.

branch of service - An arm or service of the Army.

brigade - An Army unit, usually smaller than a division, to which are attached groups and/or battalions and smaller units tailored to meet anticipated requirements.

cliff - A high, steep face of rock.

company - Basic administrative and tactical unit in most arms and services of the Army. A company is on a command level below a battalion and above a platoon; equivalent to a battery of artillery.

concave slope - A slope that curves inward, shown on a map by contours that are closer together at the top than at the bottom.

contour interval - The vertical distance between adjacent contour lines. The amount of the contour interval is given in the marginal information on the map sheet.

contour line - A line representing an imaginary line on the ground along which all points are the same elevation. Contour lines are used to indicate elevation and relief on maps.

convex slope - A slope that curves outward, shown on a map by contours that are closer together at the bottom than at the top.

coordinates - Any of a number of magnitudes or measures that determine position, as of points, planes, etc.

corps - A flexible combat force consisting of two or more attached divisions, together with supporting arms and services. Larger than a division and smaller than a field army.

cut - A place from which earth has been excavated, usually to make a more level path for a road or railroad.

declination diagram - A diagram in the margin of a map which shows the relationship between true north, magnetic north, and grid north.

depression - The angular distance of an object beneath the horizontal plane that passes through the observer.

detachment - A part of a unit separated from its main organization for duty elsewhere; equivalent in size to a platoon.

division - Major administrative and tactical unit formation which contains the necessary arms and services required for sustained combat. Larger than a regiment or brigade; smaller than a corps.

draw - A stream course that has not developed a valley floor. The distinction between the valley and the draw is in terms of movement. A valley has enough reasonably level ground to permit deployment of a military unit; the draw does not.

elevation - The height (vertical distance) of an object above or below sea level. In other words, the ups and downs in the earth's surface.

Equator - An imaginary great circle on the earth's surface, dividing the earth's surface into two equal parts: the Northern and the Southern Hemispheres. The Equator runs in an east-west direction around the earth and is of equal distance from the North and the South Poles.

fill - A place where earth has been added to a depression until a required level is reached.

geographic coordinates - A method of location based upon two sets of lines - one running east and west and the other running from the North Pole to the South Pole. The two sets of lines form a network of reference lines known as latitude and longitude.

GM angle - The angular difference between Grid north and Magnetic north on a map.

gradient - Slope expressed as a fraction, in which the vertical distance is the numerator ($\frac{2}{5}$) and the horizontal distance is the denominator ($\frac{2}{5}$). Thus, this fraction ($\frac{2}{5}$) shows the relation between vertical and horizontal distance.

grid - A number of squares drawn on a map to help locate different points accurately. In other words, a grid is a system of two sets of parallel lines intersecting at right angles and forming squares.

grid azimuth - A horizontal angle measured in a clockwise direction from the grid north base line.

grid coordinates - Numbers which identify grid lines that intersect to form grid squares on a map. Grid coordinates are made up of four, six, or eight numbers and are used to locate specific objects on a map.

grid lines - The lines drawn on a map, both vertically and horizontally, forming squares.

grid north - The north that is established by the grid lines on the map. Grid north may be symbolized by the letters GN or Y.

grid reference box - A boxed-in group of instructions on a map sheet, usually in the lower center margin. Sometimes called Grid Reference Note.

grid squares - The squares which are drawn on a map to help locate specific points. See grid above.

group - A flexible administrative and tactical unit composed of either two or more battalions or two or more squadrons. The term also applies to combat support and service support units. Equivalent to a regiment.

hachures - Short brown lines used to indicate significant ground formations not normally revealed by contour lines. They do not represent exact elevation, but are used to show relative slope in places where the contours, or other methods, do not. The shorter and closer together the lines are drawn, the steeper the slope they represent. Hachures radiating from a center indicate a peak. This method is used extensively to show mountain ranges, plateaus, and individual peaks on small-scale maps.

horizon - The uppermost junction of earth and sky.

horizontal line - A line which runs across a given surface, or east and west on a map.

interpolate - To insert values (numbers) by approximation, between known values, as in locating a point in a grid between the two grid lines whose coordinates are known.

intersection - A method of locating an unknown point on a map by (a) successively occupying two known positions, (b) taking sightings on the unmapped object from these positions, and (c) plotting the azimuths on your map. The point where the azimuths intersect is the location of the unknown object.

latitude - Distance measured in degrees (degrees of latitude) north and south from the Equator. Parallels of latitude run east and west around the globe.

lensatic compass - A type of magnetic compass equipped with a magnifying glass for reading the scale; commonly used by the military.

longitude - The arc or portion of the Equator intersected between the meridian of a given place and the prime meridian, as from Greenwich, England. The longitude of a place is expressed either in degrees or in time. For example, the longitude of New York is 74°, or 4 hours 56 minutes west of Greenwich. Meridians of longitude run north and south around the globe.

magnetic azimuth - A horizontal angle measured in a clockwise direction from the magnetic north base line.

magnetic north - The north that is established by the compass. Magnetic north is usually symbolized by a half arrowhead.

map legend - Usually found in the lower left margin of the sheet. It illustrates the topographic symbols used to depict the more prominent features on the map, such as hard-surfaced roads, unimproved dirt roads, swamps, buildings, etc.

map scale - A group of figures which express the ratio of map distance to ground distance, such as 1:50,000. This means that 1 inch measured on the map equals 50,000 inches of ground distance. Map scale is always shown in the lower center and upper left margins of the map sheet.

marginal information - Information or data given in the margins or on the borders of the map sheet.

mean sea level - The average distance between high and low tide of the ocean. For example, when a point has an elevation of 955 feet, it is 955 feet above mean sea level.

meridian - A great circle on the earth's surface passing through the North and South Poles and any other given place. This circle runs north and south around the earth and at right angles to the Equator.

meter - A measure of length equal to 39.37 inches.

military grid reference system - The system used by the Army for reading grid coordinates on a map.

orienting a map - Placing a map in a horizontal position so that the north (top) of the map points north. All map lines are then parallel to their corresponding lines on the ground.

parallel - Lying evenly elsewhere, in the same direction, but never meeting, no matter how far extended; as, parallel lines or planes.

perpendicular - A line at right angles to the plane of the horizon.

platoon - A tactical unit larger than a section; equivalent to a detachment.

profile - An exaggerated side view of a portion of the earth's surface along a line between two points.

rectangle - A four-sided figure having right angles, with opposite sides parallel and equal. Thus, a square figure is a rectangle, but a rectangle may not be a square.

regiment - Administrative and tactical unit, on a command level below a division or brigade and above a battalion; equivalent to a group.

relief (on a map) - The variation in the height of the earth's surface.

resection - A method of locating your position on the map by taking sightings on two terrain features, and plotting the back azimuths on the map. The point where these back azimuths intersect is your location.

ridge - A long, narrow elevation of ground, as a range of hills or mountains.

saddle - A ridge connecting two hills of higher elevations.

sea level - The level of the surface of the sea. Sea level is normally the zero contour line on a map.

section - A tactical unit, smaller than a platoon and larger than a squad.

slope - (1) A natural or artificial incline, as a hillside or terrace. (2) The rate of rise or fall of a ground form.

spur - A ridge or lesser elevation that extends laterally from a mountain, or range of mountains.

squad - Normally, the basic tactical unit in an organization, smaller than a section.

squadron - The basic administrative aviation unit of the Army, Navy, Marine Corps, and Air Force; equivalent to a battalion.

symbol (military) - A sign character, a letter, or an abbreviation used to represent units, branches of service, and many other aspects of the military.

tactical - Pertaining to the employment of units in combat.

terrain - An area of ground considered as to its use, as for a battlefield or for fortification.

tick marks - Very short lines used in drawing profiles to outline depressions, or used in a similar manner.

topographic symbols - Symbols used to illustrate land features and other objects which must be shown on maps. These include bridges, buildings, airports, roads, etc.

troop - A subordinate unit of a squadron; equivalent to a company or a battery. A troop has both administrative and tactical functions.

true north - A line from any position on the earth's surface to the North Pole. All lines of longitude are true north lines. True north is usually symbolized by a star.

Universal Transverse Mercator Grid (UTM) - A grid system designed for world use between 80° south latitude and 84° north latitude. This is a system of squares based on linear measurements from a point of origin. (The grid system is used by the Army for point locations or referencing.)

valley - An elongate depression, usually with an outlet, between bluffs, or between ranges of hills or mountains.

vertical line - A line which runs up and down or north and south.

APPENDIX II

SELF-TUTOR INSTRUCTION METHOD

NOTE

The following pages give a brief introductory explanation of how the SELF-TUTOR INSTRUCTION method works. Read all the information carefully and follow all instructions. Complete each of the following "frames" by writing the word or words (response) required.

1. The self-tutor Map Reading Course is presented in the same self-tutor form as the information in this introductory program.

Self-tutor materials may look like TESTS, but they are not; they are TEXTBOOKS. Let's get that straight right now -- self-tutor materials are _____; they are NOT _____.

5. Each frame gives you a little bit of new information. Then it "asks" you for some bit of _____ you learned in that frame or in an earlier one.

9. Only if you follow instructions can the program be a good _____ device. Therefore, don't look ahead at the answers. If you do, you will only _____ yourself and you will not _____.

1. textbooks;
   tests

(These are the words which you should have used to respond to frame 1 on the preceding page.)

NOW GO TO THE TOP OF PAGE 3.

5. information

9. teaching (learning);
   cheat
   learn

2. The purpose of a self-tutor textbook is to TEACH you as if you were being given private instruction. In other words, a self-tutor textbook is really your private _____ or tutor.

6. After you give your bit of _____, you quickly turn the page to see if you are _____.

10. Each program of the Map Reading Course has a short INTRODUCTION which briefly states the material to be covered, and in some cases gives other related information. Read the INTRODUCTION carefully. At the end of the course there's an examination that you must complete as a review of all the information covered in the course. After you have completed all the programs, go on and complete the examination.

Don't forget -- before you begin a program, read the _____. After you complete all the programs, review the information by completing the _____.

2. teacher

6. information;

correct (right)

10. introduction:

examination

3. A self-tutor textbook is called a PROGRAM because it presents information to be learned in small bits, a sentence or two at a time. Another name for a self-tutor textbook is a _____.

7. The faster you find out if you are correct, the better you will learn. Therefore, you must always turn the page _____ to find out if you are _____.

11. The illustrations or figures that you must use are contained at the rear of each program booklet. For example, the illustrations that you need to complete Program 2, Military Symbols Used on Maps, are at the end of the booklet 2. In most cases, the illustrations contain written as well as pictorial information; you must study the illustrations carefully to complete the course.

Remember, then, to complete the course you must study the _____ carefully.

3. program

7. quickly (fast);

correct (right)

11. illustrations

4. A program presents information in small bits, a sentence or two at a time. These bits or sentences are numbered and called FRAMES. A program, then, is made up of numbered statements, called _____.

TURN PAGE

8. Now that you know that a program is a learning device and not a test, there's no reason for you to look ahead for an answer. If you do this you will cheat yourself out of a chance to _____ from the _____.

12. To get the most out of the Map Reading Course you must proceed as follows:

a. Before you begin taking any program in the course, you must first read the _____.

b. Use and study the _____ carefully.

c. Complete the _____ in each part of the course.

d. After you have finished all parts of the course, go on and complete the _____.

KEY FRAME

4. frames

TURN TO PAGE 1, FRAME 5

8. learn;
program

TURN TO PAGE 1, FRAME 9

12. introduction; illustrations; frames; examination

If your response to a key-frame is incorrect, go back and review the intermediate frames between the one that you missed and the preceding key frame.

NOW READ PAGE 9

GENERAL INFORMATION

Note. If you are reading this page after you completed frame number 4, you are not following instructions. Please complete frames 1 through 12 as indicated by the arrowed instructions.

1. Key Frame Feature

If you have studied map reading recently, you can still use the Map Reading Course to check your knowledge of the main points that the course covers. Throughout each program there are key frames which are outlined by heavy black lines and the words KEY FRAME; frame 12 on page 19 of this booklet is an example of a key frame. The key frames are designed to prove to you that you know or can apply the information covered in a particular block of instruction. Thus, if you believe that you already know the subjects covered in the course, complete the key frames to assure yourself of this fact. After you have completed the key frames in all the programs, go on to the examination booklet and complete the examination. Key frame numbers are listed on page ii of each program booklet.

2. Responses to Frames

Your responses to the frames in the Map Reading Course can be generally classified as follows:

a. Fill-In Responses. Normally, your response to a frame is a word or words that you write in a blank space provided in the frame. With your response, the frame becomes a complete and correct bit of information or fact.

b. Multiple Choice Responses. Some frames include the multiple choice type response. Your response to the multiple choice type frame is to strike out inappropriate parenthetical terms until only the appropriate term that completes the frame is left.

c. Work-Frame Responses. Work frames require that you do something such as constructing a coordinate scale or plotting a direction on a map. Work frames normally do not require responses as in a and b above; your work performance is immediately checked by your responses to succeeding frames.

Note. Frames labelled "INFORMATION FRAME" give necessary information but do not require a response.

3. Illustrations

The illustrations for the Map Reading Course are located at the rear of each program booklet. We recommend that before you begin each program you remove the illustrations. By doing this, you can place the illustration and text side-by-side for practical use.

Now you are ready to start Program 2 of the course. The numbering system of the frames in the other programs of the course is similar to the system in this booklet. Go through the frames at the top of each page; when you get to the last page of any part, turn back to the first page and go through the frames in the second row. Continue this way until you complete the program; then go on to the next part.

ARMY EXTENSION COURSE

AVIATION SUBCOURSE 75

MAP READING

PROGRAM 2
MILITARY SYMBOLS USED ON MAPS

UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA
MAY 1966

INTRODUCTION

Program 2, Military Symbols Used on Maps, covers the rectangular troop unit symbol and the other symbols that are used to show observation posts and combat service support elements. The information below on the use of colors, as related to military symbols, is not covered elsewhere in this program.

1. When colors are used, military symbols representing friendly forces and activities are shown in blue or black, and those representing enemy forces are shown in red.

2. If only one color is available, friendly activities will be shown with single lines and enemy with double lines.

3. Symbols for minefields, demolitions, roadblocks, and other man-made obstacles, both enemy and friendly, will be shown in green.

4. Symbols for areas to be covered by friendly fire, although generally located in enemy territory, are shown in blue or black.

5. Friendly or enemy areas of chemical, biological, or radiological contamination are shown in yellow with the letters G (for chemical) or BIO (for biological) placed in the center.

6. If the color(s) used are different from those stated in 1 through 5 above, a suitable explanation should be included on the map or overlay.

TO USE THE ILLUSTRATIONS CONVENIENTLY, REMOVE THEM FROM THE REAR OF THIS BOOKLET.

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Basic Rectangular Military Symbol (Frame 1)	1
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Illustrations

Figure 1. Matching panel, military unit size identifications	17
Figure 2. Military branch of service/designation by duty identification symbols	19
Figure 3. Development of a typical military symbol	21

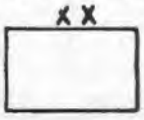
1. The basic military symbol for a troop unit is shown below. The figure is commonly called a r _____.

TURN PAGE

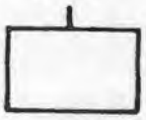
KEY FRAME

9. In the spaces provided under each troop unit symbol shown below, write the name(s) of the unit as indicated by size identification. Abbreviations may be used.

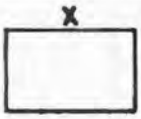
A. _____



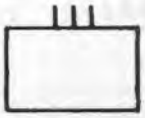
B. _____



C. _____



D. _____



E. _____

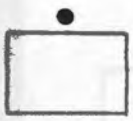
F. _____

17. Sub-parent unit identifications as shown in E through G of figure 3 are placed according to size in (ascending) (descending) order from (left to right) (right to left).

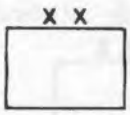
1. rectangle.

(The basic symbol for a troop unit is a rectangle.)

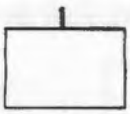
9.



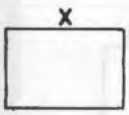
A. Squad (Sqd)



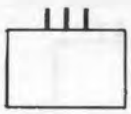
B. Division (Div)



C. Company (Co)
Troop (Trp)
Battery (Btry)



D. Brigade (Bde)



E. Group (Gp)
Regiment (Regt)

F. Army (A)

17. (ascending) (left to right)

or

(descending) (right to left)

2. An appropriate tactical size identification is placed at the top of the basic military symbol to show the size of the unit. Smaller size units are identified by dots; one for a squad, two for a section, and three for a platoon or a detachment. Place the appropriate size identifications on the troop units indicated below, as required.

SQUAD

SECTION

PLATOON
OR
DETACHMENT

10. Place the proper size identification on each of the troop unit symbols shown below.

A. Platoon or detachment

B. Battalion or squadron

C. Section

D. Corps

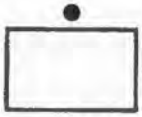
E. Army group

F. Group or regiment

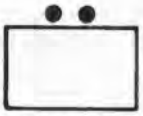
KEY FRAME

18. Explanatory information is usually written _____ (where) the military symbol.

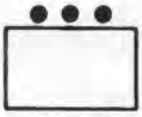
2.



SQUAD



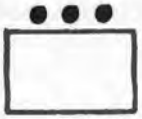
SECTION



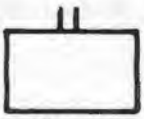
PLATOON
OR
DETACHMENT

NOTE: The section size identification (● ●) may also be used for any unit larger than a squad but smaller than a platoon.

10.

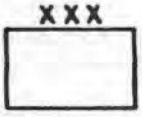


A. Platoon or detachment

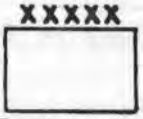


B. Battalion or squadron

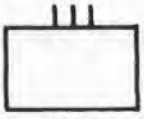
C. Section



D. Corps



E. Army group

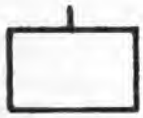


F. Group or regiment

18. underneath (below, etc.)

NOTE: Figure 3 is provided as a guide for drawing military symbols on maps, etc. On figure 3, the designation "31st Infantry" refers to the parent regiment of the 2d Battalion under the Combat Arms Regimental System (CARS). The higher echelon tactical organization, of which the 2d Battalion is a part, would be indicated either as shown, or by the boundary line symbols of the tactical organization, or by explanatory notes on the map or overlay, as required.

3. One, two, or three short vertical lines placed at the top of a basic military symbol indicate a company size, battalion size, and group size unit, respectively. Place the appropriate size identification on the troop units indicated below, as required.

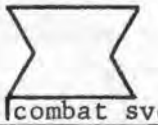


COMPANY,
BATTERY
OR
TROOP

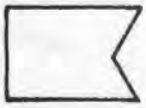
BATTALION
OR
SQUADRON

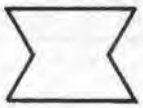
GROUP
OR
REGIMENT

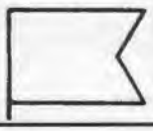
11. The basic symbols for field army support command (FASCOM) units and for combat service support units that operate within the communications zone (Comm Z) are shown below. Write identifications similar to A below to identify the symbols in B, C, and D.

A. 

Hq, combat svc spt unit (Comm Z)

B. 

C. 

D. 

19. Using figure 3 as a guide, draw the appropriate military symbol beside each of the following units. Refer to figure 2 and to the note in the response to frame 18, as required.

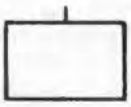
A. 42nd Signal Battalion

B. 1st Battalion, 1st Infantry

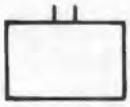
C. 2nd Platoon, Company C
1st Battalion, 2nd Armored

KEY FRAME

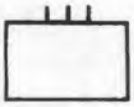
3.



COMPANY,
BATTERY
OR
TROOP

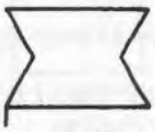


BATTALION
OR
SQUADRON



GROUP
OR
REGIMENT

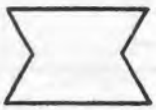
11.

A. 

Hq, combat svc spt unit (Comm Z)

B. 

Combat svc spt unit (FASCOM)

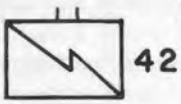
C. 

Combat svc spt unit (Comm Z)

D. 

Hq, combat svc spt unit (FASCOM)

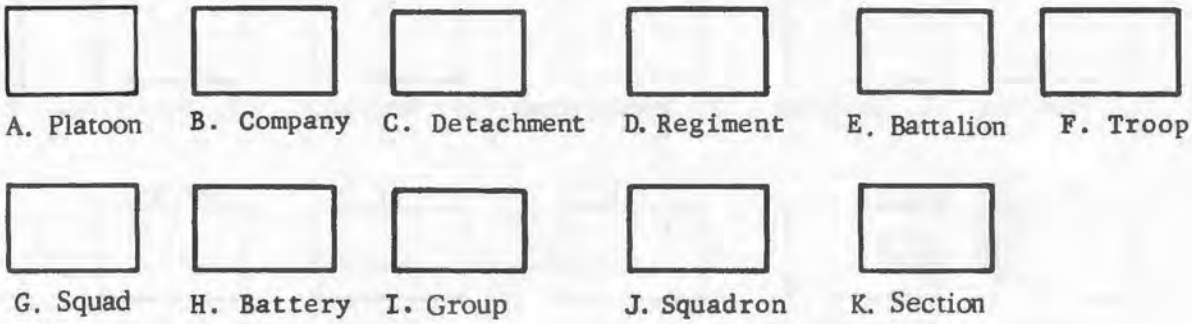
19.

A. 42nd Signal Battalion 

B. 1st Battalion, 1st Infantry 

C. 2nd Platoon, Company C,
1st Battalion, 2nd Armored 

4. Place the appropriate identification (•,• •,• • •, I, II, III) on each of the basic military symbols below to show its size.



A. Platoon B. Company C. Detachment D. Regiment E. Battalion F. Troop

G. Squad H. Battery I. Group J. Squadron K. Section

12. Refer to figure 1. On the figure, identify each symbol in column 1 with an appropriate name in column 2. Select a symbol number from column 1 and write it in column 2 next to the correct symbol name.

KEY FRAME

20. In the spaces provided below, write the complete identification for the following units

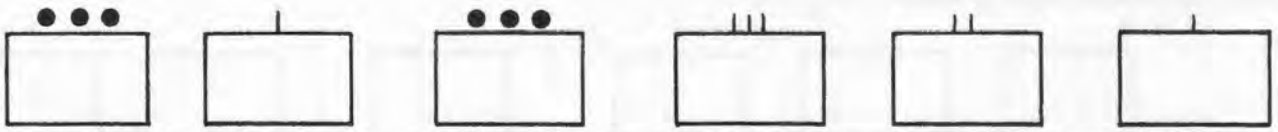
A. 1/C 2 _____, _____, _____

B. 65 _____ _____

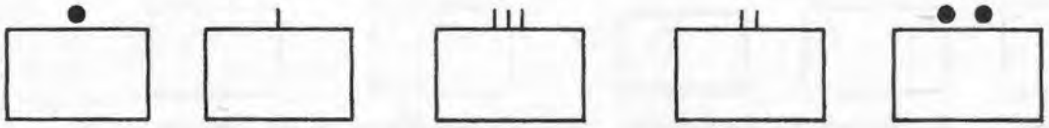
C. 2/A 1-4 _____, _____, _____

KEY FRAME

4.



A. Platoon B. Company C. Detachment D. Regiment E. Battalion F. Troop

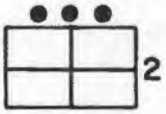


G. Squad H. Battery I. Group J. Squadron K. Section

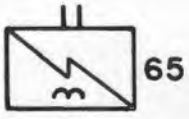
12. The numbering sequence for column 2 from top to bottom is as follows:

14, 13, 10, 1, 5, 9, 8, 11, 3, 2, 12, 7, 6, 4

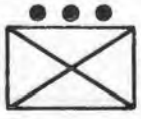
20.

A. 

1st Platoon, Company C,
2nd Medical Battalion

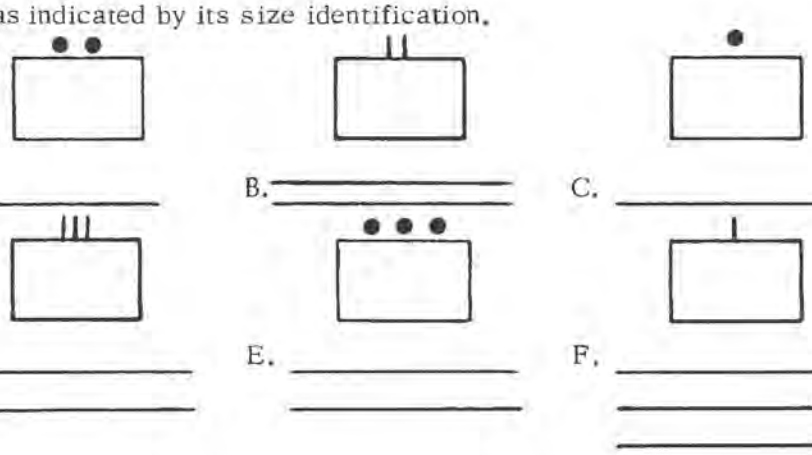
B. 

65th Airborne Signal Battalion

C. 

2nd Platoon, Company A,
1st Battalion, 4th Infantry

5. In the space provided under each troop unit symbol shown below, write the name(s) of the unit as indicated by its size identification.



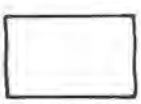
A. _____ B. _____ C. _____

D. _____ E. _____ F. _____

Names

Squad	Detachment
Section	Troop
Platoon	Regiment
Company	Squadron
Battalion	Battery
Group	

13. Study the branch of service identifications shown in figure 2. Refer to the figure and place the appropriate size and branch of service identification on each of the following troop unit symbols.

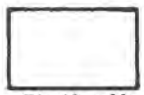


A. Signal group

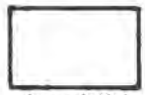
B. Airborne engineer platoon

C. Armored battalion

D. Armored engineer squad



E. Civil affairs section



F. Amphibious transportation company

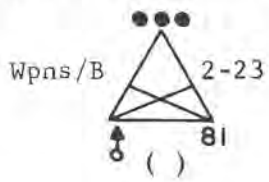
21. The military symbols shown below represent the following units:

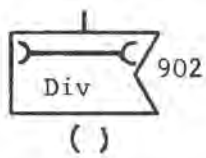
(1) 902d Division Maintenance Support Company

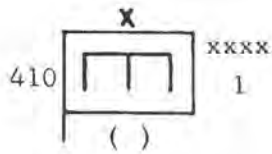
(2) Headquarters, 410th Engineer Brigade, 1st Army

(3) Observation Post, 81 mm Mortar Section, Weapons Platoon, Company B, 2nd Battalion, 23rd Infantry

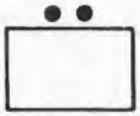
Identify each unit by writing (1), (2), or (3) in the space provided.



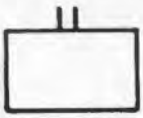




5.

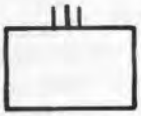


A. Section



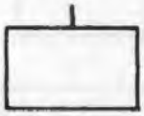
B. Battalion
Squadron

C. Squad



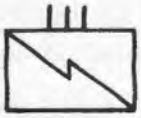
D. Regiment
Group

E. Platoon
Detachment



F. Troop Battery
Company

13.



A. Signal group

B. Airborne engineer platoon

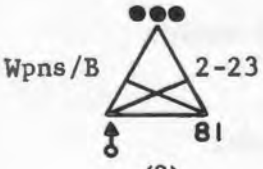
C. Armored battalion

D. Armored engineer squad

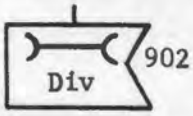
E. Civil affairs section

F. Amphibious transportation company

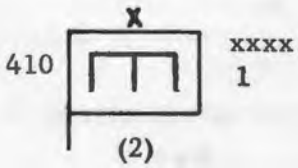
21.



(3)



(1)



(2)

6. In the spaces provided below, list the names of the troop units that you have covered. Beside each name, draw a basic troop unit symbol and place the appropriate size identification on the symbol.

KEY FRAME

	Symbol		Symbol
A.	_____	D.	_____
B.	_____	E.	_____
C.	_____	F.	_____

14. Refer to figure 2 and identify the following military symbols. Write your identification in the space provided.

A.  _____ _____ _____

B.  _____ _____ _____

C. 

_____ _____ _____

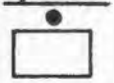
D.  _____ _____

---

22. The basic military symbol for a troop unit is a rectangle. Refer to the response for the preceding frame and in the spaces below draw the basic military symbols for A, B, C, and D below.

	Symbol
A. An observation post	
B. A headquarters or command post	
C. A supply point such as a depot	
D. A FASCOM combat service support unit..	

6.

	Symbol		Symbol
A. Squad →		D. Company, troop or battery →	
B. Section →		E. Battalion or squadron →	
C. Platoon or detachment →		F. Group or regiment →	

14.

A. Airborne signal battalion 

B. Armored reconnaissance battalion 

C. General supply company 

D. Finance company 

22.

	Symbol
A. An observation post	
B. A headquarters or command post ..	
C. A supply point such as a depot	
D. A FASCOM combat service support unit	

7. Higher echelon units are indicated, according to their size, by X through X X X X X (brigade through army group). Complete the following chart by placing size identifications on the troop unit symbols. The units are listed in order according to size.

Unit	Symbol
Brigade	☐
Division	☐
Corps	☐
Army	☐
Army group	☐

15. Refer to figure 2 and draw the military symbols for the following in the spaces provided above the names of the units.

A. Medical company

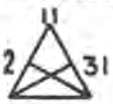
B. Amphibious engineer company

C. Infantry (mechanized) brigade

D. Airmobile battalion

E. Military police platoon

23. The size, branch of service, and unit identifications are placed on the basic symbols for an observation post, a supply or service point, and a headquarters unit in the same manner as shown on figures 2 and 3 for a troop unit. Use figures 2 and 3 as guides and write the complete identification for A, B, and C below in the spaces provided.

A. 

O_____ ____; ____ _____,
_____ _____

B. 

Class III S_____ _____, ____ _____
_____

C. 

H_____, ____ _____ _____

7.

Unit	Symbol
Brigade	X
Division	XX
Corps	XXX
Army	XXXX
Army group	XXXXX

15.

A. Medical company

B. Amphibious engineer company

C. Infantry (mechanized) brigade

Air-mobile 

D. Airmobile battalion

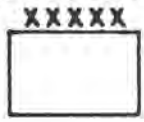
E. Military police platoon

23. A. Observation Post, 2nd Battalion, 31st Infantry

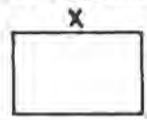
B. Class III Supply Point, 31st Infantry Division

C. Headquarters, 2nd Infantry Division

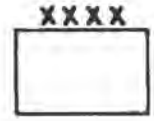
8. In the spaces provided under each troop unit symbol shown below, write the name of the unit as indicated by its size identification.



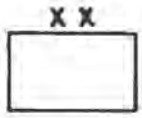
A. _____ _____



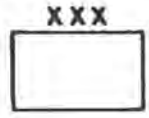
B. _____



C. _____



D. _____



E. _____

Names

Brigade
Division
Corps
Army
Army Group

16. Study figure 3 which shows the development of a complete military symbol. Notice in C of the figure that the parent unit identification is always placed on the (right) (left) of the military symbol.

24. Beside each name of the military units listed below, draw the symbol that you would use to represent the unit on a map.

A. 65th Tank Battalion,
4th Armored

B. Headquarters,
211th Signal Battalion
(construction)

C. Observation Post,
Company D,
2nd Battalion,
3rd Infantry

D. Engineer Depot,
Number 508,
1st Army

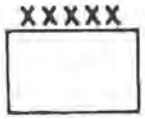
E. Headquarters,
1st Corps Artillery

F. 2nd Platoon,
Company C,
40th Airborne
Signal Battalion

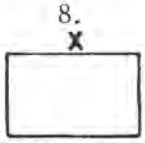
KEY FRAME

8.

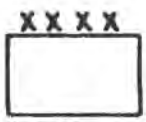
A. Army Group



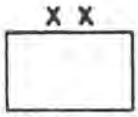
B. Brigade



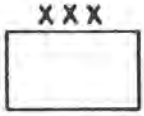
C. Army



D. Division



E. Corps

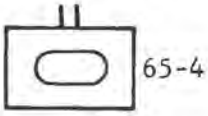


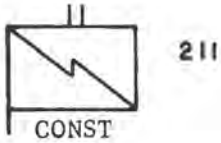
TURN TO PAGE 1
FRAME 9

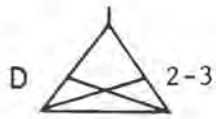
16. (right)

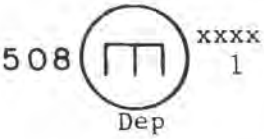
TURN TO PAGE 1
FRAME 17

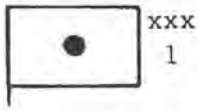
24.

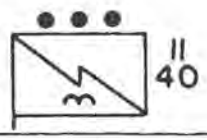
A. 

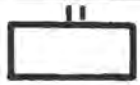
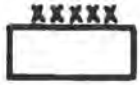
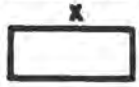
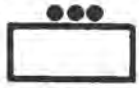
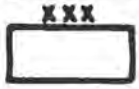
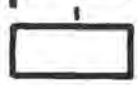
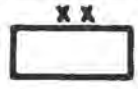
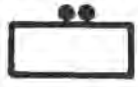
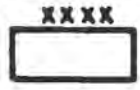
B. 

C. 

D. 

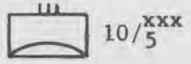
E. 

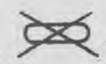
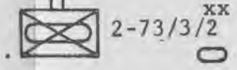
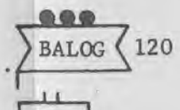
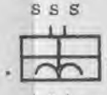
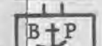
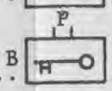
F. 

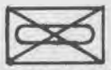
COLUMN 1	
NR	SYMBOL
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	

COLUMN 2	
NR	SYMBOL NAME
	SQUAD
	ARMY
	DIVISION
	BATTALION, SQUADRON
	BRIGADE
	COMPANY, TROOP, BATTERY
	HQ, COMBAT SVC SPT UNIT (FASCOM)
	SECTION
	COMBAT SVC SPT UNIT (COMM Z)
	ARMY GROUP
	COMBAT SVC SPT UNIT (FASCOM)
	CORPS
	PLATOON, DETACHMENT
	GROUP, REGIMENT

FIGURE 1. MATCHING PANEL, MILITARY UNIT SIZE IDENTICATIONS.

BRANCH OF SERVICE/ DESIGNATION BY DUTY	SYMBOL[a]	EXAMPLE	
Airborne[b]			(Airborne Inf. Platoon)
Air Defense			(10th Air Defense Gp, 5th Corps)
Air Force			(Helicopter Landing Area)
Amphibious[b]			(Amphibious Engineer Section)
Armor			(Armored Battalion)
Army Aviation		Air-mobile  16	(Airmobile Co, 16th Avn Bn)
Army Security Agency	ASA	 2116 Rad Intel	(2116th Radio Intelligence Co, U.S. Army Security Agency)
Artillery (Field)			(1st Inf. Div. Arty.)
Cavalry (Reconnaissance)			(Armored Cavalry Co.)
Chemical			(Chemical Section)
Civil Affairs			(Civil Affairs Co.)
Data Processing Unit	DPU	 410	(410th Data Processing Unit, Type X, Fixed)
Engineer			(Engineer Company)
FASCOM Units		 42	(42d Army Rear Support (RS) Brigade)
Finance			(Finance Company)

BRANCH OF SERVICE/ DESIGNATION BY DUTY	SYMBOL[a]	EXAMPLE	
Infantry			(Infantry Battalion)
Infantry (Mechanized)[a]		 2-73/3/2 xx	(2d Bn (Mech), 73d Inf, 3d Bde, 2d Armored Div)
Logistical Command		 BALOG 120	(Hq, Base Log Comd with 121st Log Comd as the Comd Hq)
Marine Corps Units	 SSS	 SSS	(Tank Battalion)
Medical Service		 212	(212th Med Bn (Airborne))
Military Intelligence	MI	 MI 30	(30th Military Intelligence Battalion (FIELD ARMY))
Military Police	MP	 MP	(Military Police Platoon)
Naval Units (General)		 B P	(Division Beach Party)
Ordnance			(Ordnance Battalion)
Postal Units		 21 Base	(21st Base Post Office (type P))
Quartermaster		 B 681DS	(Co B, 681st QM Bn (Direct Support))
Replacement Unit	Repl	 Hq Repl 12	(Hq Detachment, 12th Replacement Battalion)
Signal		 746 Base Dep	(746th Signal Co (Base Depot))
Supply[c]		 908 FWD	(908th QM Petroleum Supply Co (Forward))
Transportation		 421 Trk	(421st Transportation Group (Truck))

[a]Symbols may be combined, for example  (Inf. Div. (Mechanized)).

[b]Symbol is always used with some other identification symbol.

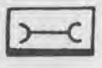
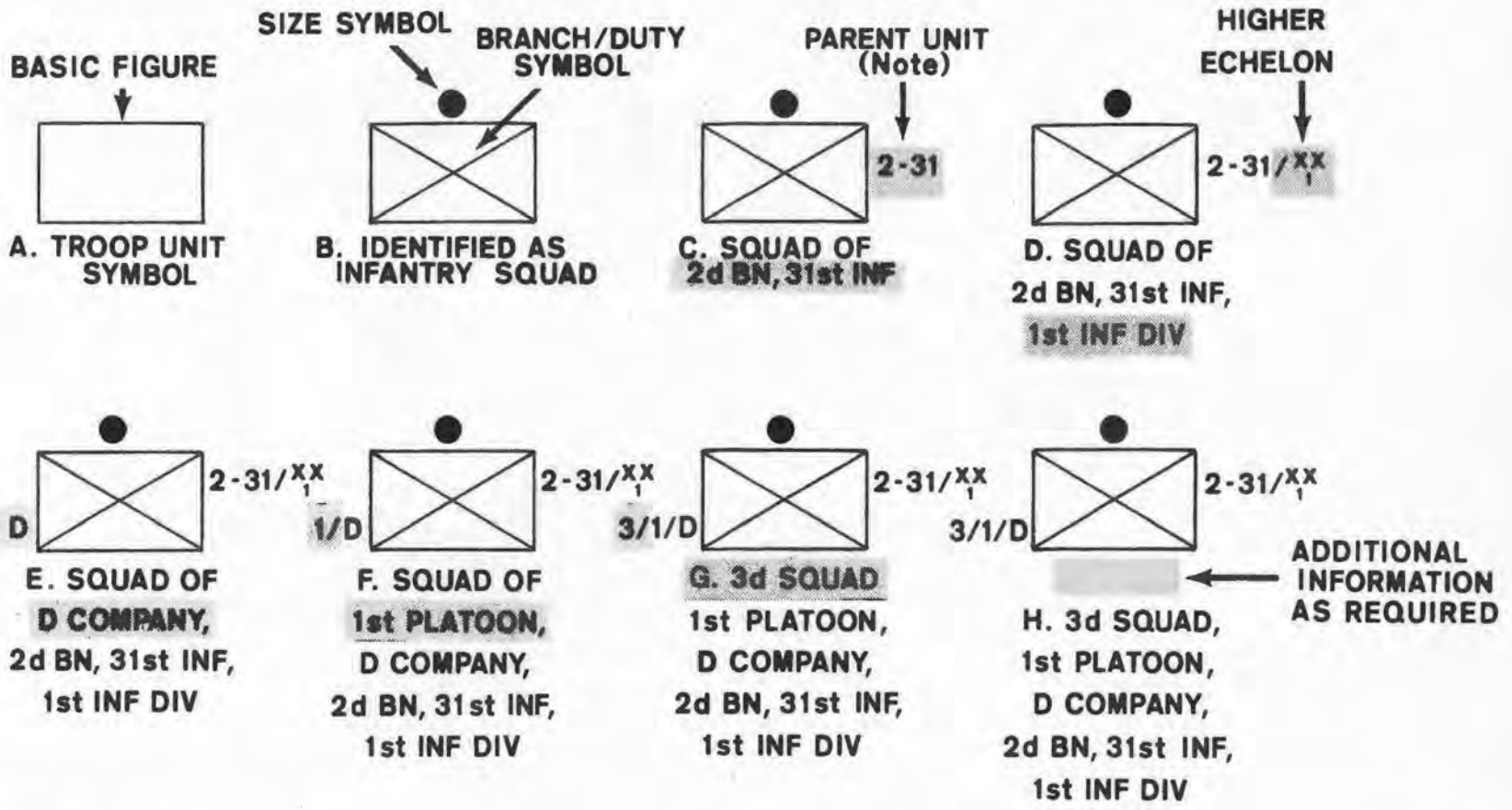
[c]Open-end wrench () denotes maintenance. Supply and maintenance activities may be combined: 

FIGURE 2. MILITARY BRANCH OF SERVICE/ DESIGNATION BY DUTY IDENTIFICATION SYMBOLS.



NOTE:
IN THE CASE OF SEPARATE UNITS THAT HAVE NO PARENT UNIT, THE SEPARATE UNIT IDENTIFICATION IS PLACED TO THE RIGHT OF THE MILITARY SYMBOL.

FIGURE 3. DEVELOPMENT OF A TYPICAL MILITARY SYMBOL.

ARMY
EXTENSION COURSE

AVIATION SUBCOURSE 75
MAP READING

PROGRAM 3
MILITARY GRID REFERENCE SYSTEM

UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA
MAY 1966

INTRODUCTION

Program 3, Military Grid Reference System, covers the military grid reference system used for reading grid coordinates on a Universal Transverse Mercator Grid (UTM) map. Most of the military maps include the UTM grid. Although only a 1:50,000 map is used in Program 3, the "Read-Right-Up" system of reading grid coordinates and the method of referencing map locations apply to any scale map that uses the UTM grid. The grid reference box which appears in the marginal information of each map sheet contains step-by-step instructions for using the UTM grid and the military grid reference system.

Note: You will need a piece of bond paper or thin cardboard (3" x 3" or larger) with square corners, and the map of Mineral Wells, Tex., 1:50,000, Sheet 6349 I, to complete Program 3.

TO USE THE ILLUSTRATIONS CONVENIENTLY, REMOVE THEM FROM THE REAR OF THIS BOOKLET.

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Eight-Digit Grid Coordinates (Frames 18-21)	5
Grid Coordinate Scale (Frames 22-27).	13
Vertical and Horizontal Components of a Grid Coordinate Number (Frames 28-36).	25
Grid Reference Box (Frames 37-43).	13
Key Frames 6, 12, 17, 26, 27, 35, 36, and 43	11, 23, 3, 21, 23, 9, 11, and 25, respectively

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INFORMATION FRAME

1. Refer to your map of **Mineral Wells.** The grid lines on the map are the horizontal and vertical lines that extend between the bottom and top margins and between the right and left margins. Each grid line is identified by a number; the grid line numbers are printed along the outer edge of the map.

TURN PAGE

16. Now look at figure 4 which shows how we can read grid coordinates inside a grid square. Part A of the figure is an enlarged representation of grid square 3312 on which imaginary grid lines have been projected. Reading RIGHT-UP, the six-digit grid coordinate of the 100 x 100 grid square "X" is 330120. Write the six-digit grid coordinates for grid squares "Y" and "Z". _____ _____

31. Grid coordinate numbers 6380, 672546, and 59236812 are written correctly because they all contain an _____ _____ of digits.

1. Go to frame 2.

16. 330129 ("Y")

339120 ("Z")

31. even number

(When properly written, a grid coordinate number contains an even number of digits.)

2. The number of the third vertical grid line from the left hand margin of your Mineral Wells map is $\overset{5}{73}$. Write the number of the sixth vertical grid line. _____

17. What is the six-digit grid coordinate of building BLDG in grid square 3312 on figure 4? _____

KEY FRAME

32. When properly written, a grid coordinate number can be separated into two distinct vertical and horizontal components, each of which contains an even number of digits. For example, in grid coordinate 79506435, 7950 is the _____ component and 6435 is the _____ component.

2. $\underline{5_{76}}$

17. 334125

32. vertical (7950)

horizontal (6435)

3. The second horizontal grid line from the bottom edge of your map is $^{36}25$. The third horizontal grid line is _____.

18. Notice that the imaginary grid lines on part A of figure 4 divide grid square 3312 into smaller grid squares, each of which represents 100 x 100 meters or 10,000 square meters in ground area. In part B of the figure, grid square 339129, in turn, has been divided so that by reading RIGHT-UP we can now give eight-digit grid coordinates for locations inside the 100 x 100 meter area. The eight-digit grid coordinate for the northern intersection of Burrs Mill Brook and the trail in part B of figure 4 is _____.

33. How many digits do the vertical components of the following contain?

a. A four digit grid coordinate number _____

b. A six digit grid coordinate number _____

c. An eight digit grid coordinate number _____

3. $\underline{36_{26}}$

18. 33931293

33. a. 2

b. 3

c. 4

4. Only the larger figures of a grid line number are used for normal map reading identification. Starting from the lower left corner of your Mineral Wells map, write the numbers that you would normally use to identify the following grid lines.

	Vertical		Horizontal
6th	76 (example)	3rd	26 (example)
8th	_____	5th	_____
10th	_____	8th	_____

19. Write the eight-digit grid coordinate for the southern intersection of Burrs Mill Brook and the trail in part B of figure 4. _____

34. Will the vertical and horizontal components of a correctly written grid coordinate number always contain the same number of digits? (Answer yes or no) _____

4.

	Vertical		Horizontal	
6th	76	(example)	3rd	26 (example)
8th	78		5th	28
10th	80		8th	31

19. 33941292

34. Yes

5. Grid lines divide a map into grid squares. Each grid square is identified by writing the numbers of the grid lines that intersect to form the lower left corner of the grid square. The numbers are then called a grid coordinate. For example, the grid coordinate of the first complete grid square in the lower left corner of your Mineral Wells map is 7124. Write the grid coordinate of the next adjacent grid square to the right of the one in the example.

_____

20. Refer to part A of figure 4. Write the eight-digit grid coordinate of the approximate center of building BLDG. _____

35. Separate the following grid coordinates into their vertical and horizontal components.

Grid coordinate	Vertical component	Horizontal component
8765	_____	_____
49328764	_____	_____
357241	_____	_____

KEY FRAME

5. 7224

20. 33431252

35.

Vertical component	Horizontal component
87	65
4932	8764
357	241

6. Listed below are two grid coordinates taken from your **Mineral Wells** map. In the spaces provided, write the names of the **cemeteries** included in the grid squares indicated by the grid coordinates.

a. 7729 _____ _____ **Cemetery**

b. 8925 _____ _____ **Cemetery**

KEY FRAME

21. To determine eight-digit grid coordinates for locations on your **Mineral Wells** map, use the meters bar scale on the map and make a grid coordinate scale. Refer to part A of figure 5 and use it as a guide in making the scale.

36. Refer to figure 6 and write the grid coordinates to the nearest 10 meters, for the units listed below, on the spaces provided.

A. 1st Brigade Headquarters, 1st Infantry Division . . . . . _____

B. **Headquarters, 3d Military Police Brigade.** . . . . . _____

C. **233d Heavy Materiel Supply Company.** . . . . . _____

D. Division Headquarters, 1st Infantry Division . . . . . _____

KEY FRAME

6. a. 7729 Indian Creek Cemetery

b. 8925 Old Millsap Cemetery

21. Make grid coordinate scale.

36. A. 25012624

B. 22422357

C. 21912105

D. 26652295

7. Notice that in the grid coordinates that you have used so far -- 7124, 7224, 7729, and 8925 -- the vertical grid line number is always written first and is followed by the _____ grid line number.

22. Now that you have constructed the grid coordinate scale, look at part B of figure 5 which shows how to use it. Notice that the corner of the coordinate scale is positioned on the object to be _____.

37. Although you can identify a location on any map by its grid coordinates, you must also identify the overall map area when you are writing or transmitting the location. You can identify the map area by referring to the grid reference box that appears in the center of the bottom margin on your map. Find the grid reference box on your Mineral Wells map.

7. horizontal

22. located

37.

GRID ZONE DESIGNATION: 14S	TO GIVE A STANDARD REFERENCE ON THIS SHEET TO NEAREST 100 METERS		
100,000 M. SQUARE IDENTIFICATION	SAMPLE POINT: CEMETERY		
NM	1. Read letters identifying 100,000 meter square in which the point lies:	NM	
	2. Locate first VERTICAL grid line to LEFT of point and read LARGE figures labeling the line either in the top or bottom margin, or on the line itself:	84	
	Estimate tenths from grid line to point:	0	
	3. Locate first HORIZONTAL grid line BELOW point and read LARGE figures labeling the line either in the left or right margin, or on the line itself:		41
IGNORE the SMALLER figures of any grid number; these are for finding the full coordinates. Use ONLY the LARGER figures of the grid number; example: 3624000	Estimate tenths from grid line to point:		8
	SAMPLE REFERENCE:	NM840418	
	If reporting beyond 18° in any direction, prefix Grid Zone Designation, as:	14SNM840418	

8. In writing grid coordinates, the correct method is to write the _____ grid line number first, then the _____.

23. The edges of the coordinate scale should be kept parallel to the _____ _____ on the map.

38. Study figure 7. Notice that grid zone 1N designates a 6^{O} x 8^{O} area of the world's surface. The letters CG within grid zone 1N locate a _____ _____ _____.

8. vertical

horizontal

(In writing grid coordinates, the correct method is to write the vertical grid line number first, then the horizontal.)

23. grid lines

38. 100,000 meter square

9. Refer to your Mineral Wells map. The grid line numbers that are arranged in sequence from left to R I G H T are the _____ grid line numbers.

24. The grid coordinate scale which you constructed from your Mineral Wells map can only be used on military maps with a scale ratio of _____.

39. When the map area falls in more than one 100,000 meter square, the grid line that separates the 100,000 meter squares is shown in the grid reference box and the value for the grid line is given. In the grid reference box below, the map area falls in 100,000 meter squares identified as ____ ____ and ____ ____.

9. vertical

(Vertical grid line numbers are read R I G H T.)

24. 1:50,000

39. E S and E T

10. The grid line numbers that are arranged in sequence from the bottom to the top or U P the map are the _____, grid line numbers.

25. Refer to part B of figure 5 and complete the following statements.

a. The first and second and the fifth and sixth digits of an eight-digit grid coordinate number are determined by the _____ _____ numbers on the map.

b. The third and seventh digits of an eight-digit grid coordinate number can be determined directly from the markings on the _____ _____ _____.

c. The fourth and eighth digits of an eight-digit grid coordinate number are normally _____.

40. Notice the sample reference 16SET885044 shown in the grid reference box below. Is the sample reference point, Indian Mound, located within the upper or lower part of the map area? _____.

GRID ZONE DESIGNATION 16S	TO GIVE A STANDARD REFERENCE ON THIS SHEET TO NEAREST 100 METERS
100,000 M SQUARE IDENTIFICATION	SAMPLE POINT: INDIAN MOUND
ET 4200 ES	1. Locate first VERTICAL grid line to LEFT of point and read LARGE figures labeling this line either in the top or bottom margin, or on the line itself: Estimate tenths from grid line to point: 5 2. Locate first HORIZONTAL grid line BELOW point and read LARGE figures labeling this line either in the left or right margin, or on the line itself: Estimate tenths from grid line to point: 4
IGNORE the SMALLER figures of any grid number. these are for finding the full coordinates. Use ONLY the LARGER figures of the grid number; example: 4193000	SAMPLE REFERENCE: 885044 If reporting beyond 100,000 meters or if sheet bears an overlapping grid, prefix 100,000 Meter Square Identification, as: ET885044 If reporting beyond 18° in any direction, prefix Grid Zone Designation, as: 16SET885044

10. horizontal

(Horizontal grid line numbers are read U P.)

25. a. grid line

(The first and second and the fifth and sixth digits of an eight-digit grid coordinate number are determined by the grid line numbers on the map.)

b. grid coordinate scale.

(The third and seventh digits of an eight-digit grid coordinate number can be determined directly from the markings on the grid coordinate scale.)

c. estimated.

(The fourth and eighth digits of an eight-digit grid grid coordinate number are normally estimated.)

40. Upper.

11. The rule for reading or writing grid coordinates, then, is stated as follows:

READ _____ - _____.

26. Use the grid coordinate scale that you constructed and determine eight-digit grid coordinates for the following items on your Mineral Wells map. Write the coordinates in the spaces provided.

a. The school in grid square 8331 _____

b. The armory in grid square 8630 _____

c. The pond in grid square 8041 _____

KEY FRAME

41. The writing of a military grid reference consists of a group of letters and numbers which indicate the grid zone designation, the 100,000 meter square identification, and the grid coordinate of the location. The reference is written as a continuous series of numbers and letters without spaces, dashes, or decimal points. Identify the parts of the grid reference shown below.

Reference: 16SET91750106

Grid Zone Designation is _____

100,000 M Square Identification is _____

Grid coordinate is _____

11. RIGHT - UP

26. a. 83233165

b. 86443053

c. 80914107

Note. Because the 4th and 8th digits of an eight-digit grid coordinate are estimated, these digits may vary by ±2 in your responses.

41. 16S (Grid Zone Designation)

ET (100,000 M Square Identification)

91750106 (Grid coordinate)

12. Locate and mark the grid square at 9044 on your Mineral Wells map. Identify the eight adjacent grid squares by writing their grid coordinates in the spaces below. Start with the grid square directly below 9044 and list them in clockwise rotation.

1. 9043 (example) 2. _____ 3. _____ 4. _____

5. _____ 6. _____ 7. _____ 8. _____

KEY FRAME

27. In the spaces provided below, write the names of the objects located at the following grid coordinates on the Mineral Wells map.

a. 88302773 _____

b. 76322982 _____

c. 73682508 _____

KEY FRAME

42. In the spaces below, write the names of the parts of military grid reference 18TWV79506572.

A. 18T is the _____.

B. WV is the _____.

C. 79506572 is the _____.

12. 1. 9043 (example) 2. 8943 3. 8944 4. 8945
5. 9045 6. 9145 7. 9144 8. 9143

27. a. Beacon
b. Rodeo Ground
c. Peak of Barber Mountain

42. A. Grid Zone Designation
B. 100,000 M Square Identification
C. Grid coordinate

13. Locate the grid square at grid coordinate 8233 on your Mineral Wells map. Use the meters bar scale on the map and measure the sides of the square. Each side represents (10) (100) (1,000) (10,000) meters.

28. Locate grid coordinate 9293495 on your Mineral Wells map and place a check mark beside the item below that it identifies.

a. Post Dump

b. Shed

c. Impossible to determine

43. Refer to your Mineral Wells map and write the grid reference for the following in the spaces provided.

A. The radio tower in grid square 8428. _____

B. BM 1007 in grid square 8039. ____

KEY FRAME

13. (1,000)

28. C. Impossible to determine. Note. It is not correct to assume that the last digit was omitted. For example, the incomplete grid coordinate 3251261 originally may have been 32501261, 32512610, 32531261, or any other combination of digits which can be translated as a location on the map.

43. A. 14SNM84382886

B. 14SNM80153910

14. The actual ground area represented by grid square 3312 is 1,000 x 1,000 meters or _____ square meters.

29. Obviously there is something wrong with grid coordinate 9293495. All of the grid coordinate numbers that you have determined or used thus far have contained an even number of digits -- and this is always true. All grid coordinate numbers must contain an _____ number of digits.

END OF PROGRAM 3

14. 1,000,000 square meters

29. even

15. For many military purposes, a grid square is too large an area (1,000,000 square meters) to reference as a location. Therefore, we must use grid coordinates that allow us to reference a location inside a _____ _____.

30. Which of the following grid coordinate numbers are written correctly? (Indicate by check marks.)

a. 56321

b. 672546

c. 6380

d. 59236812

e. 3281659

15. grid square

TURN TO PAGE 1
FRAME 16

---

30. b, c, and d.

TURN TO PAGE 1
FRAME 31

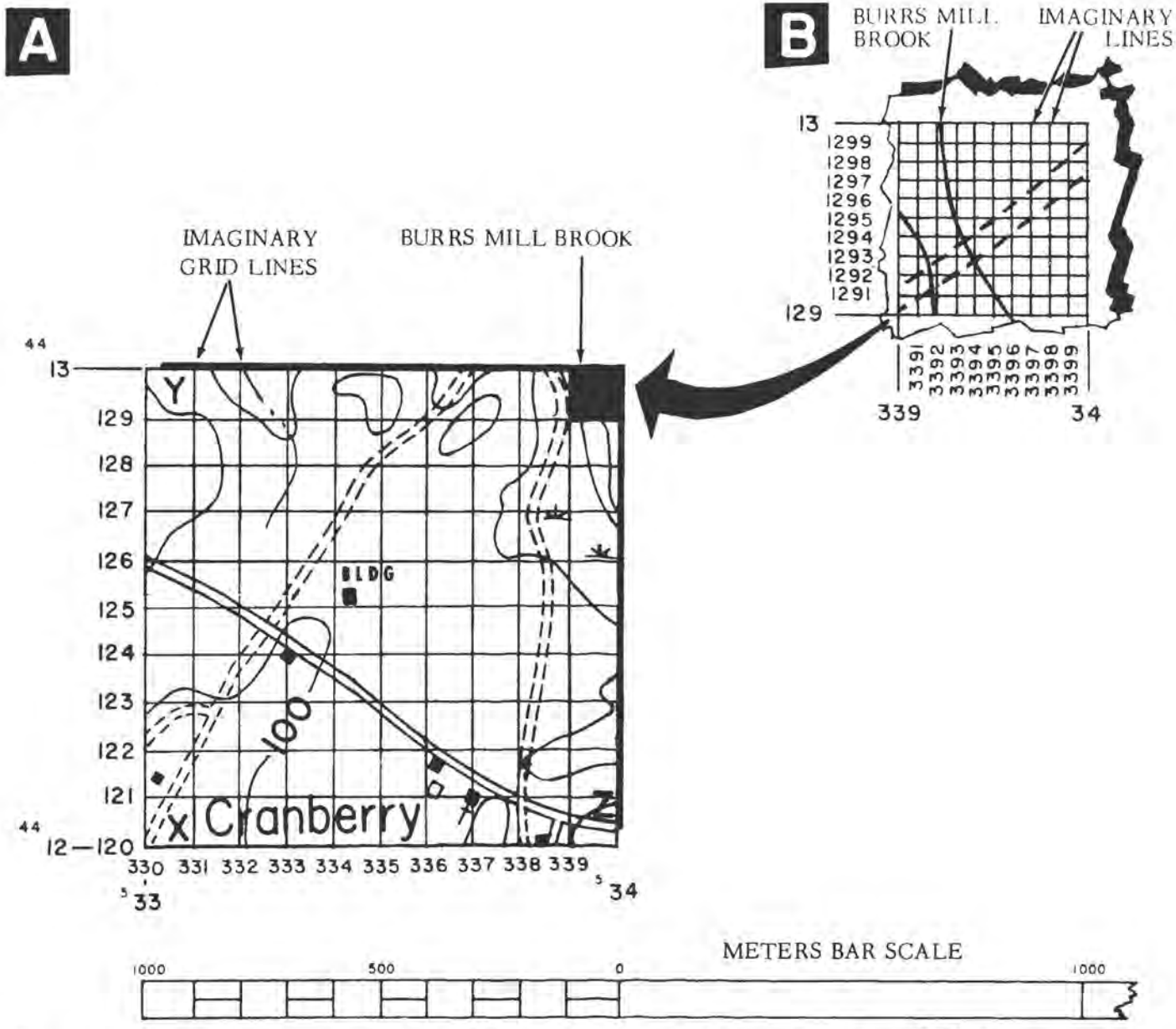

Figure 4. Reading grid coordinates to locate within a 10 x 10 meter area on a 1:50,000 map.

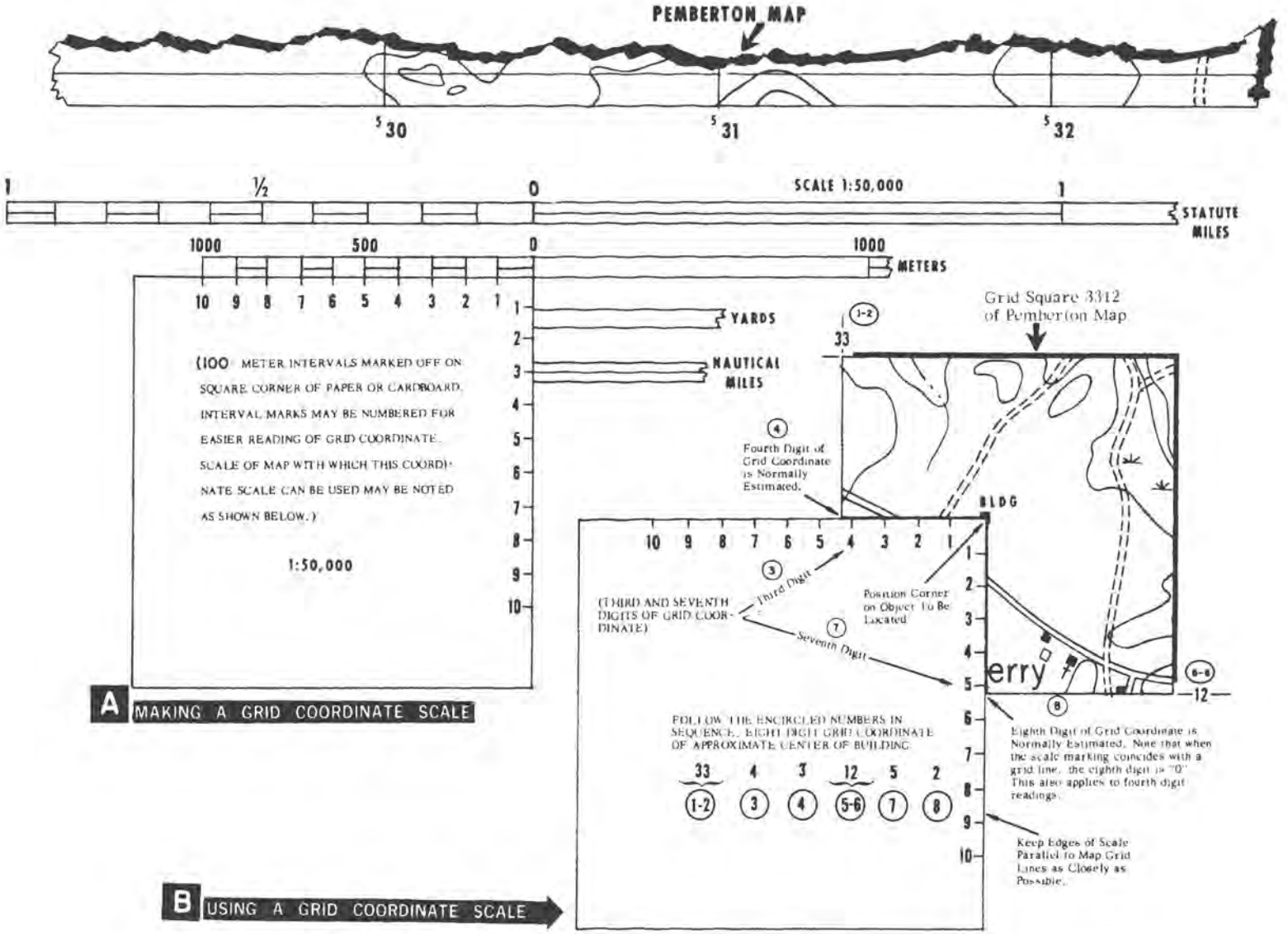

Figure 5. Construction and use of a grid coordinate scale for a 1:50,000 map.

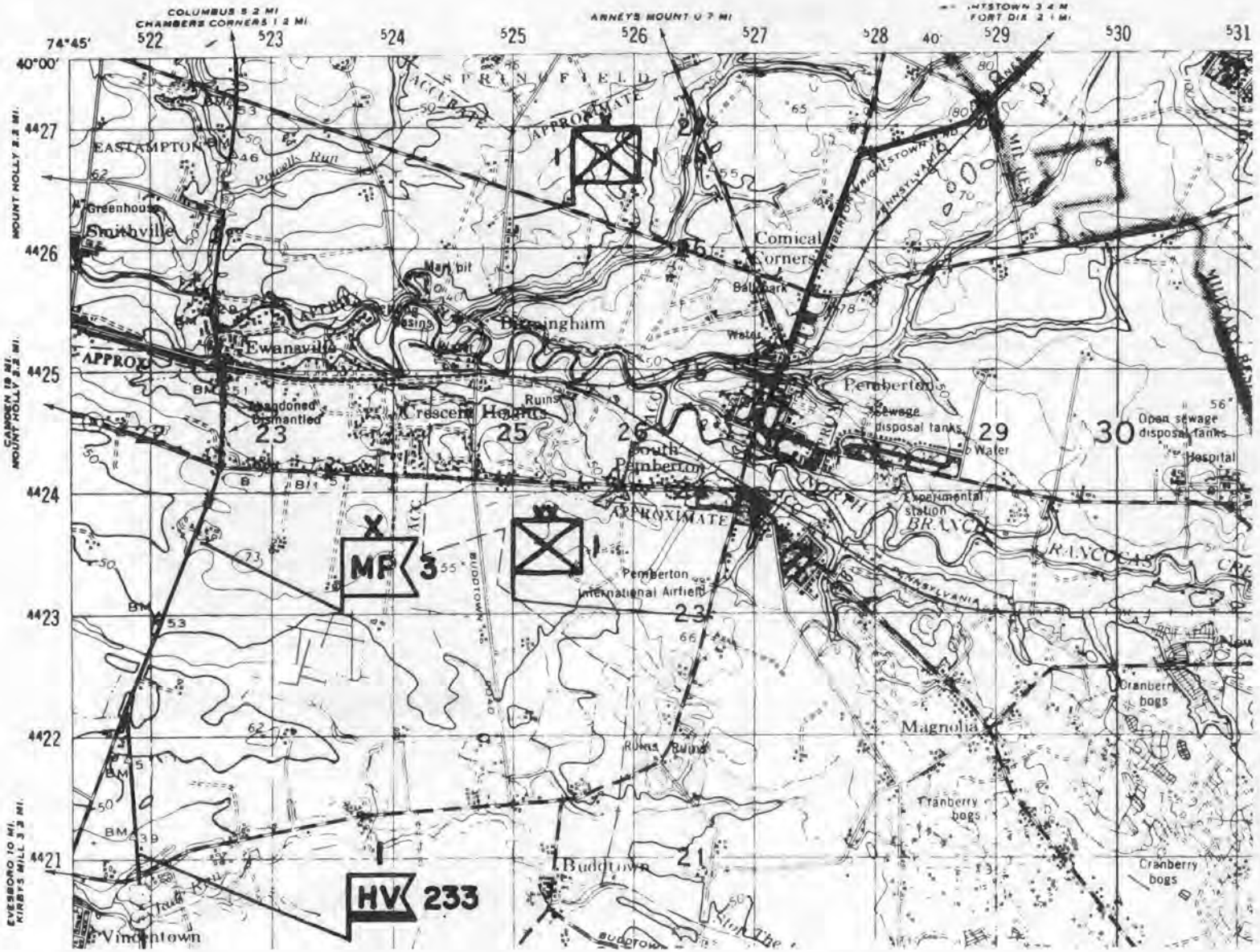

Figure 6. Map segment for use with frame 36, Program 3, of Map Reading Course.

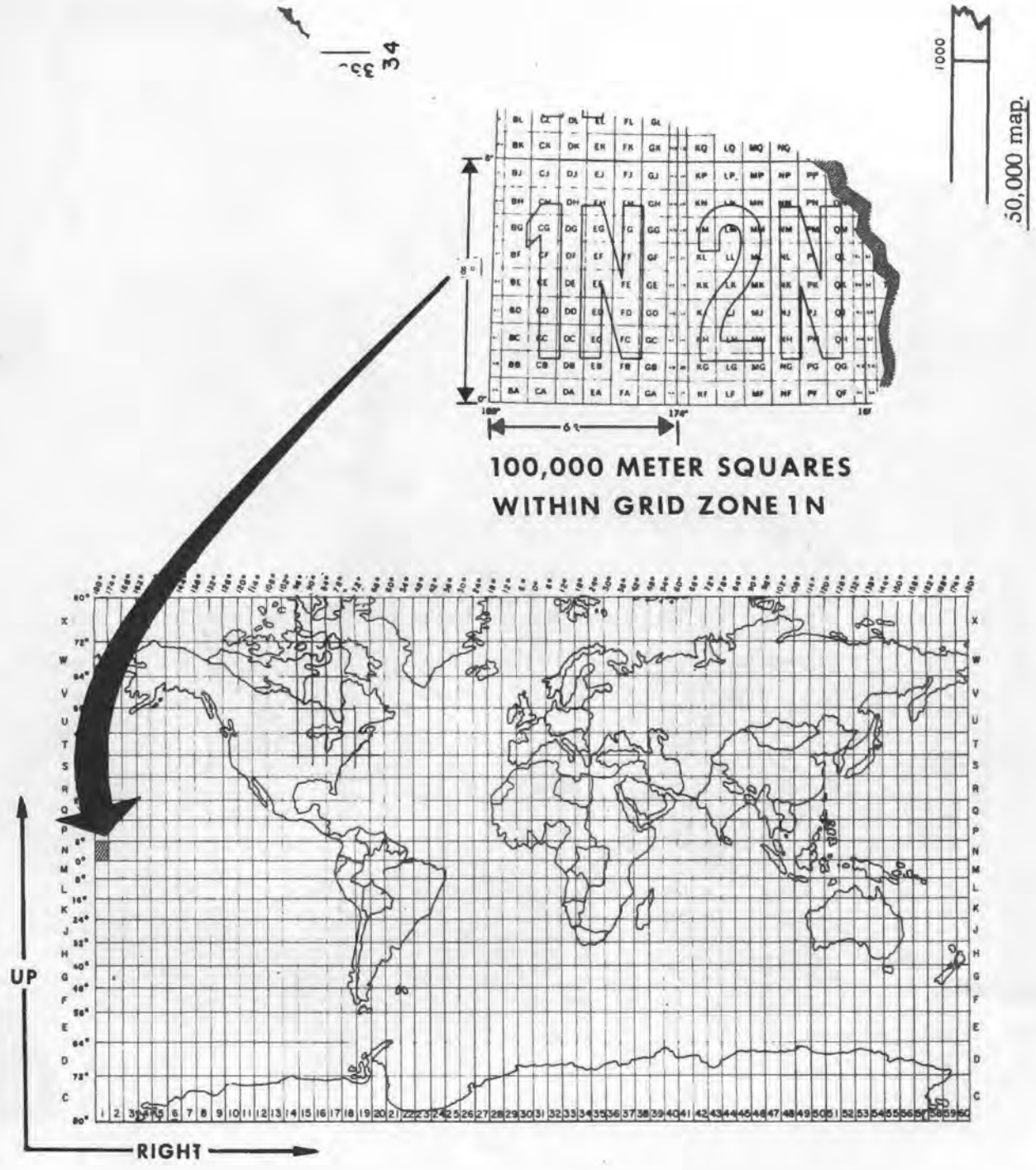

Figure 7. Grid Zone Designation and 100,000 Meter Square Identification.

ARMY EXTENSION COURSE

AVIATION SUBCOURSE 75
MAP READING

PROGRAM 4
DIRECTIONS

UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA
MAY 1966

INTRODUCTION

Program 4, Directions, covers a method used to determine a direction by using any one of three base lines: grid, magnetic, or true north base line as a reference. Azimuths and back azimuths, and the use of the declination diagram on a map are also covered.

Note: You will need a protractor and a straightedge to complete Program 4.

TO USE THE ILLUSTRATIONS CONVENIENTLY, REMOVE THEM FROM THE REAR OF THIS BOOKLET.

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1. Figure 8 shows the three base lines from which directions are measured. Refer to the figure and complete the following chart.

Base Line	Symbol	Derived From
True north	★	. . . . _____ _____ _____
Magnetic north	1	. . . . _____ _____ _____
Grid north	"GN" or "Y"	. . . . _____ _____ _____

TURN PAGE

19. Study the declination diagram shown on figure 11. If a true north base line were plotted on the Fort Knox map, it would intersect a vertical grid line at an angle of _____° _____'.

37. In 1963, the magnetic azimuth from A to C on figure 13 is _____° _____'.

1. earth's north pole;

compass direction of magnetic north;

vertical grid lines on a map

19. $0^{\circ}\ 39'$

37. $125^{\circ}\ 15'$

2. Refer to figure 8 and write the names of the base lines indicated by the symbols below.

Symbol	Name
1	_____
"GN or "Y"	_____
★	_____

20. Refer to figure 11 and complete the following statement. "The angle at which a magnetic north base line plotted on a map intersects a vertical grid line is known as the _____ _____ _____."

38. In the spaces below, write the azimuths from X to Y on figure 13.

Grid azimuth is ____° ____'

Magnetic azimuth (1963) is ____° ____'

KEY FRAME

2. Symbol — Name

 ——— Magnetic north

"GN" or "Y" —— Grid north

 ——— True north

20. GM angle

38. 305° 00′ (Grid azimuth);

316° 15′ (Magnetic azimuth)

3. Under the diagrams below, write the name of the base line from which the indicated direction is measured or referenced.

A. _____ _____

B. _____ _____

C. _____ _____

21. The constant angular difference between true north and grid north is called _____ _____.

39. In the spaces below, write the azimuths from Y to X on figure 13.

A. Grid azimuth is _____° _____'

B. Magnetic azimuth (1963) _____° _____'

KEY FRAME

3. A. True north

B. Grid north

C. Magnetic north

21. grid declination

39. $125^{\circ}\ 00'$ (Grid azimuth = 305°-180′)

$136^{\circ}\ 15'$ (Magnetic azimuth = $316^{\circ}\ 15' - 180^{\circ}$)

4. On diagram B of the preceding frame, instead of "GN" we could have used the letter "_____".

22. The chart on figure 11 lists the magnetic declination for 1963 as 2^{o} 07'. This tells us that in 1963, 2^{o} 07' is the angular difference between _____ and _____.

40. You are standing at bench mark BM 740 located at the bottom-left of figure 14. Use your protractor and straightedge to plot a grid north base line through BM 740.

4. "Y"

22. magnetic north and true north

40. Go to frame 41.

5. In the spaces below, write the names of the base lines, draw their symbols, and briefly state their derivation.

Name	Symbol	Derivation
_____	_____	_____
_____	_____	_____
_____	_____	_____

KEY FRAME

23. Figure 11 also shows that in the Fort Knox area, the magnetic declination changes (1° 54') (1° 15') (0° 39') (1' EASTERLY) each year.

---

41. You are ordered to proceed from BM 740 in a north easterly direction at a magnetic azimuth of 72° 02'. Use the declination diagram on figure 14 to convert from magnetic to grid azimuth; determine the azimuth for 1963. The grid azimuth is ____° ____'.

5.

Name	Symbol	Derivation
Grid north	"GN" or "Y"	Vertical grid lines on map.
Magnetic north		Compass direction of magnetic north.
True north	★	Earth's north pole.

23. 1′ EASTERLY

41. 73° 30′

6. The magnetic, true, and grid north base lines are used in measuring direction by azimuth. Which base line was used in measuring the direction of the silo in figure 9?

_____.

24. The magnetic declination for 1964 is listed in the chart on figure 11 as 2^{o} 08′. The magnetic declination for 1965, 1966, and 1967 will be _____ ^{o} _____′, _____ ^{o} _____′, and _____ ^{o} _____′, respectively.

KEY FRAME

42. Plot the grid azimuth of 73^{o} 30′ from BM 740 on figure 14.

6. magnetic north base line

24. $2^{\circ}\ 09'$, $2^{\circ}\ 10'$, and $2^{\circ}\ 11'$, respectively

42. Go to frame 43.

7. Part B of figure 9 shows that the magnetic azimuth angle is measured in a (clockwise) (counterclockwise) direction from the base line.

25. In 1963, the angular difference between grid north and magnetic north is listed in the chart on figure 11 as $1^{o}\ 28'$. In 1964, 1965, and 1966, the GM angle will be _____ ^{o} _____ ', _____ ^{o} _____ ', and _____ ^{o} _____ ', respectively.

KEY FRAME

43. Your proposed route of march takes you through bench mark BM _____.

7. (clockwise)

25. $1^{\circ}\,29'$, $1^{\circ}\,30'$, and $1^{\circ}\,31'$, respectively

43. BM 462

8. All azimuth angles are measured in the same manner -- they are measured in a _____ direction from the base line.

26. A comparison of the values in the chart on figure 11 shows that the amount of change in the GM angle is (the same as) (0^{O} 1′ more then) (0^{O} 1′ less than) the annual magnetic change.

KEY FRAME

44. Subsequent orders state that you will proceed from BM 462 at a magnetic azimuth of 341^{O} 02′ (use the reading as taken in 1963) and halt at the first trail you encounter. Determine the grid azimuth for 1963; plot your new direction of march on figure 14.

8. clockwise

(All azimuth angles are measured in a clockwise direction from the base line.)

26. (the same as)

44. Go to frame 45.

9. A "true azimuth of 63^{o}" is a direction. It tells us that --

a. The azimuth angle of 63^{o} was measured in a _____ direction.

b. The base line used as a reference for measuring was _____ _____.

27. On figure 11, notice that the GM angle and the magnetic declination are not equal in value, but the amount and the direction of change are _____.

KEY FRAME

45. Note: Frames 40 through 45 cover a single exercise in plotting directions. You must complete frames 40-44 to respond to frame 45.

Based on the order in the preceding frame, you will halt at _____

KEY FRAME

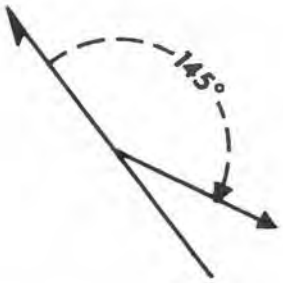
9. a. clockwise;

   b. true north

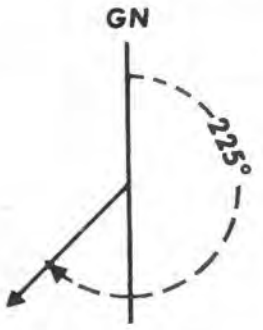
27. the same or equal (either one)

45. BM 471

10. In the spaces below, write the directions indicated in sketches A and B.



A. _____ _____ of _____ °



B. _____ _____ of _____ °

28. Study figure 12 and compare the angular values for 1950 and 1963.

In 1950, the grid azimuth from BM 786 to BM 460 was _____ ° _____ ′; in 1963 the grid azimuth is _____ ° _____ ′.

46. Now you are within the area covered by figure 15. Locate bench marks BM 471 and BM 462 and plot a grid north base line through each.

10. A. Magnetic azimuth of 145^{o}

B. Grid azimuth of 225^{o}

---

28. $57^{o}\ 30'$; $57^{o}\ 30'$

(On any one map, the grid declination remains constant, therefore, the grid azimuth between any two points will remain constant.)

---

46. Go to frame 47.

---

11. On the appropriate base lines shown below, roughly sketch in the following directions (label the angle, and show the direction from the base line from which the angle was measured):

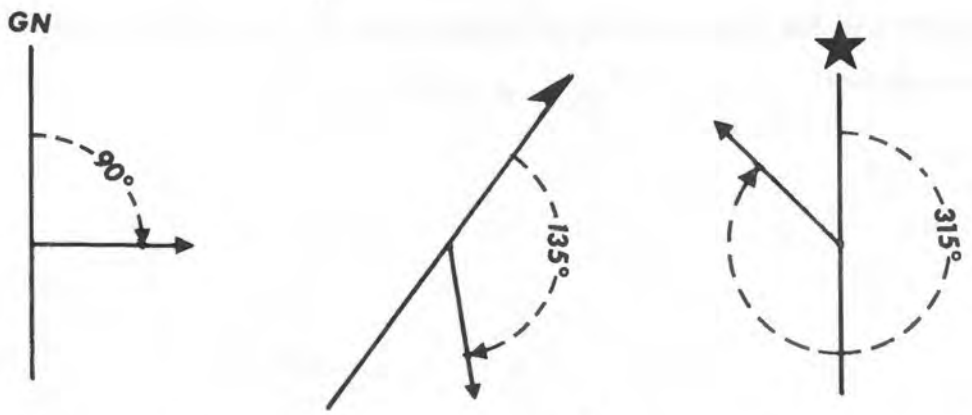
a. Grid azimuth of 90^{o}. b. Magnetic azimuth of 135^{o}. c. True azimuth of 315^{o}.

KEY FRAME

29. Based on the grid azimuth of 57^{o} 30', what will the magnetic azimuth from BM 786 to BM 460 be in 1965? _____ ^{o} _____ '

47. From your position, the magnetic azimuth on BM 471 is 46^{o} 02'. Use the declination diagram and convert this magnetic azimuth to grid azimuth; determine the grid azimuth for 1963. The grid azimuth is _____ ^{o} _____ '.

11.



a. Grid azimuth of 90^{o} b. Magnetic azimuth of 135^{o} c. True azimuth of 315^{o}.

29. $56^{o}\ 00'$

47. $47^{o}\ 30'$

12. Study figure 10. The figure shows that back azimuth angles, like azimuth angles, are also measured in a _____ direction from the base line.

30. On figure 12. the grid azimuth from BM 786 to BM 747 is 329^{o} 30'. Considering the GM angle, what is the 1963 magnetic azimuth between these two points?

___ ° ___ '.

KEY FRAME

48. Convert the grid azimuth of 47^{o} 30' to grid back azimuth. The grid back azimuth is

___ ° ___ '.

12. clockwise

(Back azimuth angles are measured in a clockwise direction from the base line.)

30. 328^{o} 02'

48. 227^{o} 30'

(When the grid azimuth is less than 180^{o}, you add 180^{o} to the grid azimuth to determine grid back azimuth.)

13. Figure 10 also shows that back azimuth is determined from an azimuth by either adding or subtracting _____°.

31. Study figure 13. The declination diagram on the figure shows that the GM angle is _____° _____′.

49. Use your protractor and straightedge to plot the grid back azimuth of 227° 30′ from BM 471 on figure 15.

13. $\underline{180^{\circ}}$

31. $\underline{11^{\circ}\ 15'}$

49. Go to frame 50.

14. When the azimuth angle is 180^{o} or less, to find the back azimuth you _____ _____ ^{o}.

32. The declination diagram on figure 13 also states that for each year after 1955, magnetic azimuths must be adjusted by $(11^{o}\ 15')\ (0^{o}\ 32')\ (0^{o})$.

50. From your position, you also take a sighting on BM 462. The magnetic azimuth to BM 462 is $126^{o}\ 32'$. Convert this magnetic azimuth to grid azimuth; deter. ne the grid azimuth for 1963. The grid azimuth is _____ ^{o} _____ .

14. add 180^{o}

(When the azimuth angle is 180^{o} or less, to find the back azimuth you add 180^{o}.)

32. (0^{o})

50. $128^{o}\ 00'$

15. When the azimuth angle is greater than 180^{o}, to find back azimuth you _____ ^{o} _____.

33. Use your protractor to measure the grid azimuth from A to B on figure 13. The grid azimuth is _____ ^{o} _____'.

51. Convert the grid azimuth of 128^{o} to grid back azimuth. The grid back azimuth is _____ ^{o}.

15. subtract 180^{o}

(When the azimuth angle is greater than 180^{o}, to find back azimuth you subtract 180^{o}.)

33. $36^{o}\ 00'$

51. 308^{o}

16. Determine the back azimuths for the directions listed below and write them in the spaces provided.

a. Grid azimuth = 25^{o}; grid back azimuth = _____^{o}.

b. Magnetic azimuth = 204^{o}; magnetic back azimuth = _____^{o}.

c. True azimuth = 316^{o}; true back azimuth = _____^{o}.

d. Grid azimuth = 87^{o}; grid back azimuth = _____^{o}.

KEY FRAME

34. After determining the grid azimuth from A to B on figure 13, you can determine the magnetic azimuth by (adding) (subtracting) 11^{o} 15'.

---

52. Plot the grid back azimuth of 308^{o} from BM 462 on figure 15.

---

16. a. 205°

b. 24°

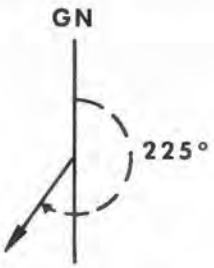
c. 136°

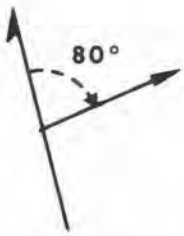
d. 267°

34. (adding)

52. Go to frame 53.

17. The sketches below show two back azimuth angles. In the space below each sketch, write the original azimuth angle from which the back azimuth angle was derived.





A. ____°

B. ____°

KEY FRAME

35. Using the grid azimuth of 36° from A to B on figure 13, determine the magnetic azimuth for 1963. The magnetic azimuth is ____° ____'.

53. Note: Frames 46 through 53 are a single exercise that covers the main points of this program on directions. You must complete frames 46-52 to respond to frame 53.

Extend the grid back azimuth lines on figure 15 until they intersect. Notice that the point of intersection is the point from which the original magnetic azimuths were taken. The point of intersection marks your location which is in the _____ __

KEY FRAME

17. A. 45^{o}

B. 260^{o}

35. $47^{o}\ 15'$

53. Long Cemetery

INFORMATION FRAME

18. Azimuths and back azimuths can be plotted accurately on a map by referring to the declination diagram on the map. A declination diagram indicates the angular difference (declination): (1) between grid north and true north, and (2) between magnetic north and true north.

---

36. Use your protractor to determine the grid azimuth from A to C on figure 13. The grid azimuth is _____° _____'.

END OF PROGRAM 4

18. Go to frame 19 on page 1.

---

36. $114^{\circ}\ 00'$

TURN TO PAGE 1
FRAME 37

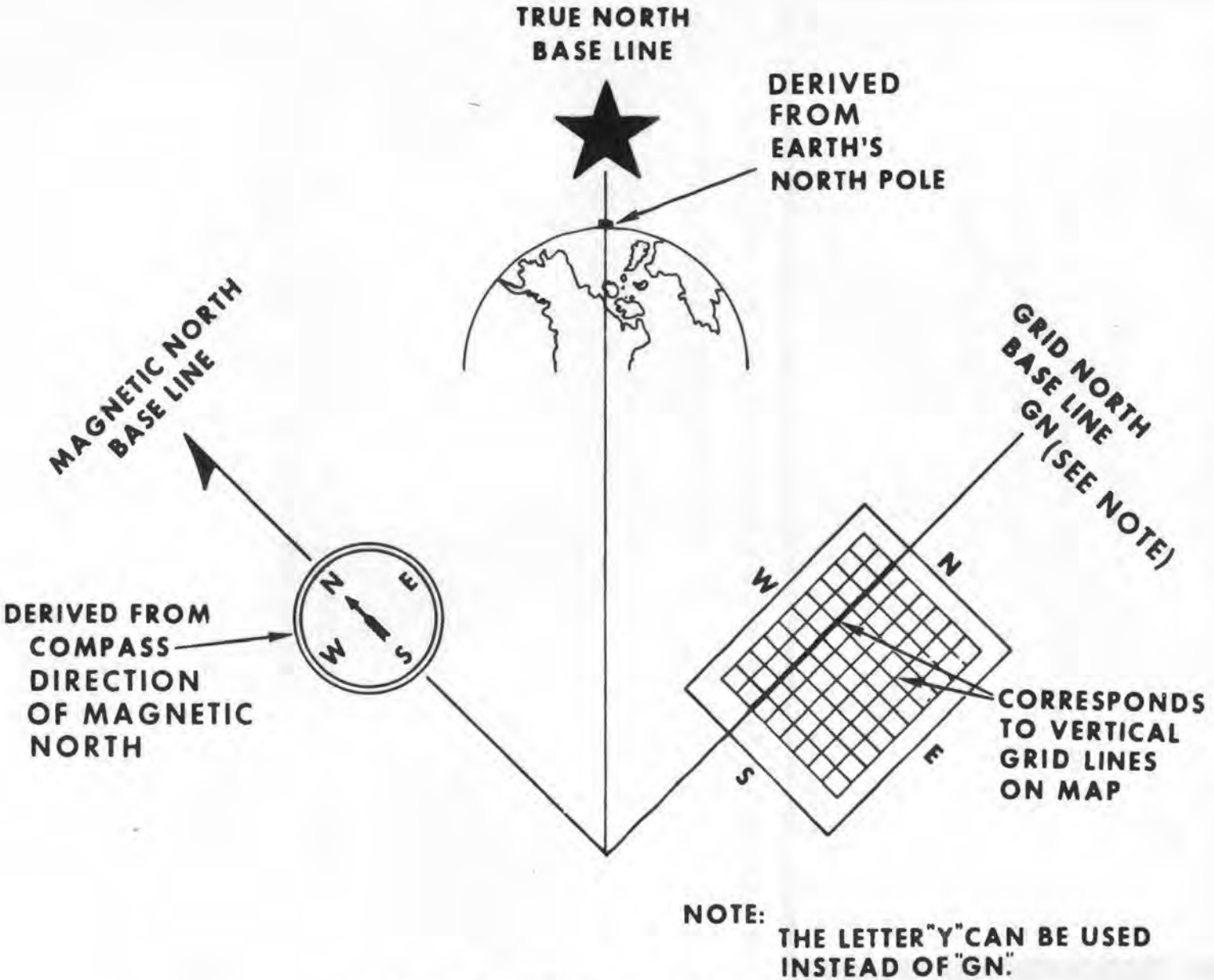
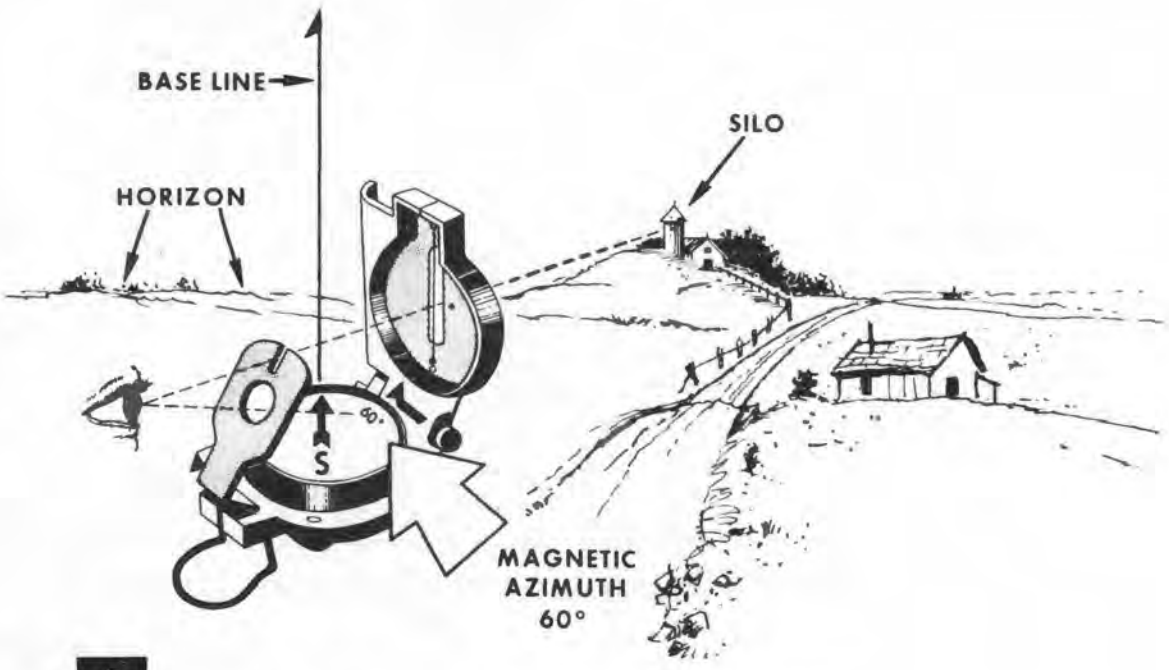
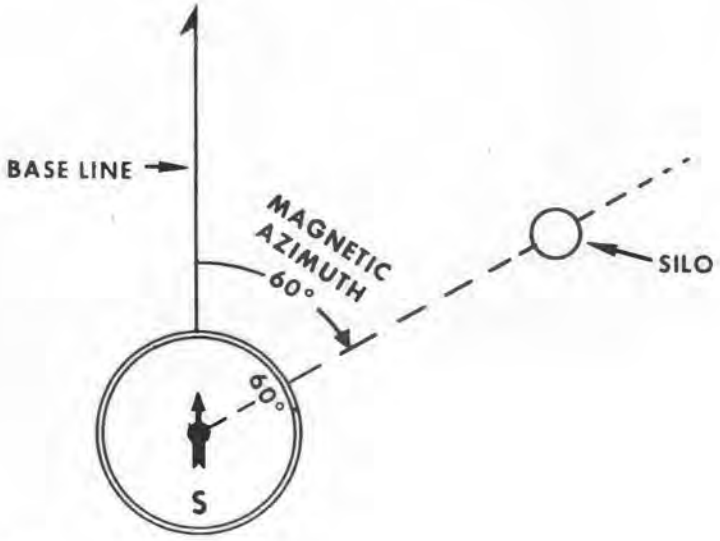


Figure 8. Base lines and their derivations.



A OBSERVER MEASURES AZIMUTH ON THE HORIZON.



B SIMPLIFIED VIEW OF AZIMUTH MEASUREMENT AS SEEN FROM ABOVE THE OBSERVER.

Figure 9. Measurement of a magnetic azimuth.

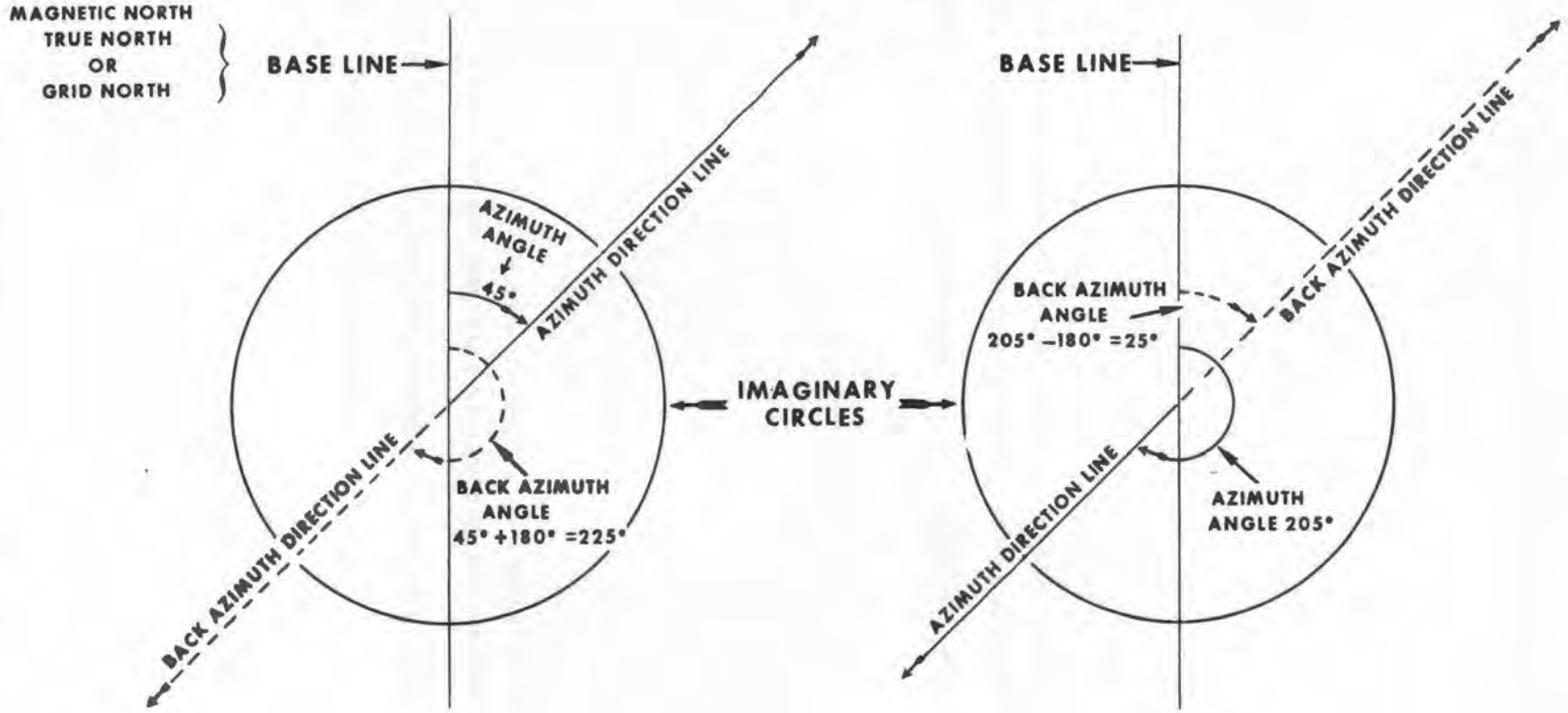
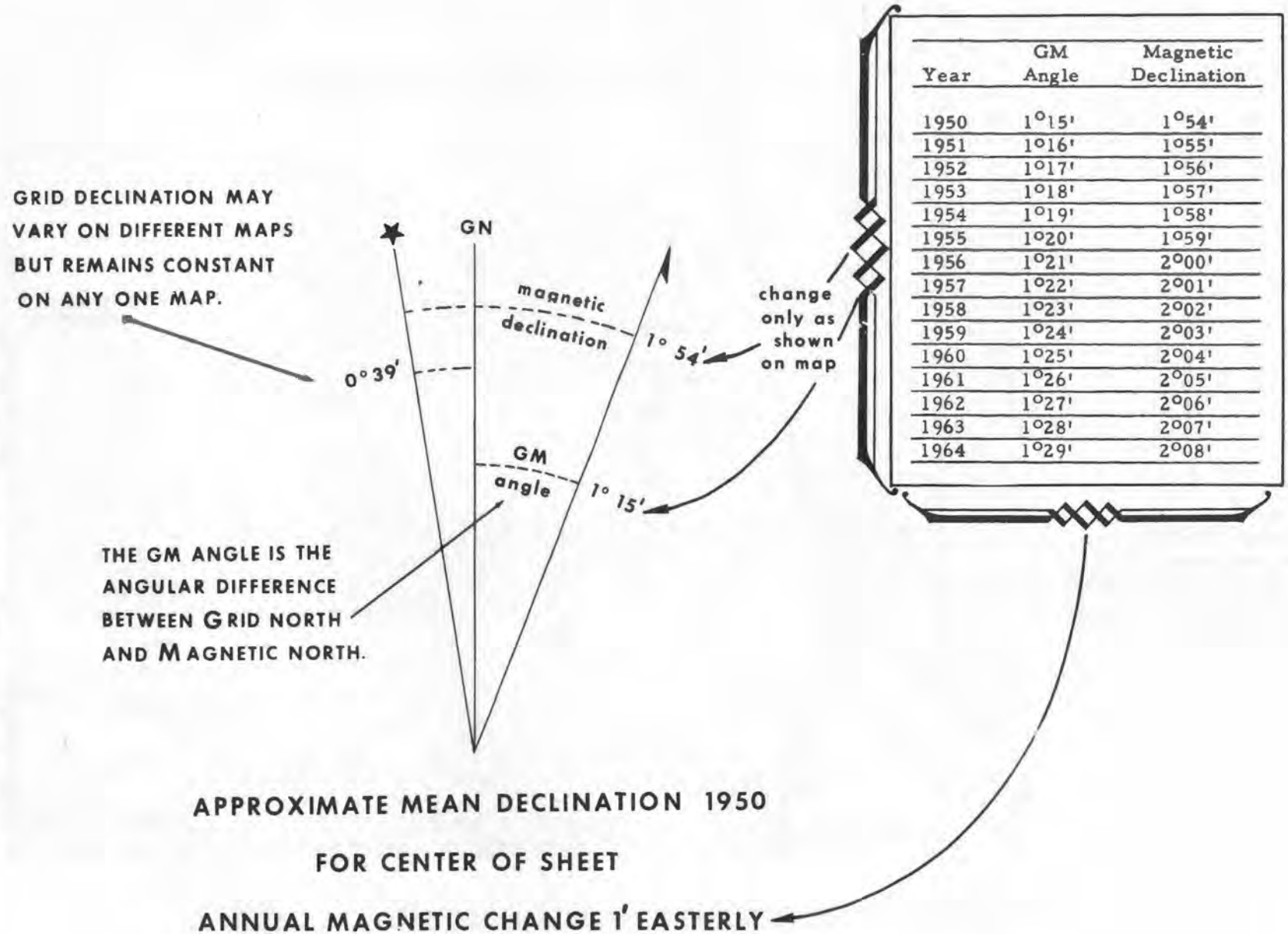


Figure 10. Determining back azimuth angles.



Year	GM Angle	Magnetic Declination
1950	1°15'	1°54'
1951	1°16'	1°55'
1952	1°17'	1°56'
1953	1°18'	1°57'
1954	1°19'	1°58'
1955	1°20'	1°59'
1956	1°21'	2°00'
1957	1°22'	2°01'
1958	1°23'	2°02'
1959	1°24'	2°03'
1960	1°25'	2°04'
1961	1°26'	2°05'
1962	1°27'	2°06'
1963	1°28'	2°07'
1964	1°29'	2°08'

Figure 11. Declination diagram taken from Fort Knox map sheet.

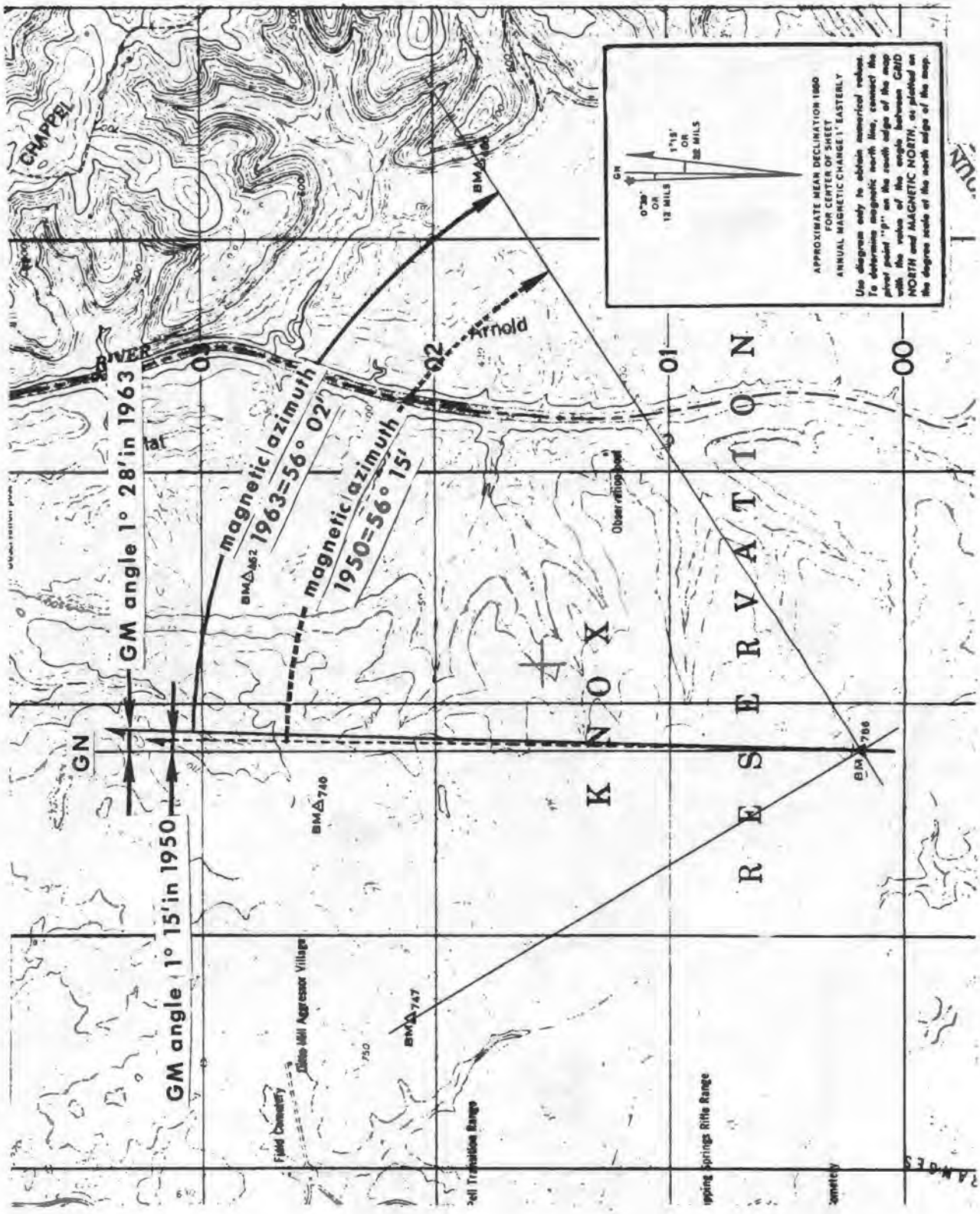


Figure 12. Map segment for use with frames 28-30 of Program 4.

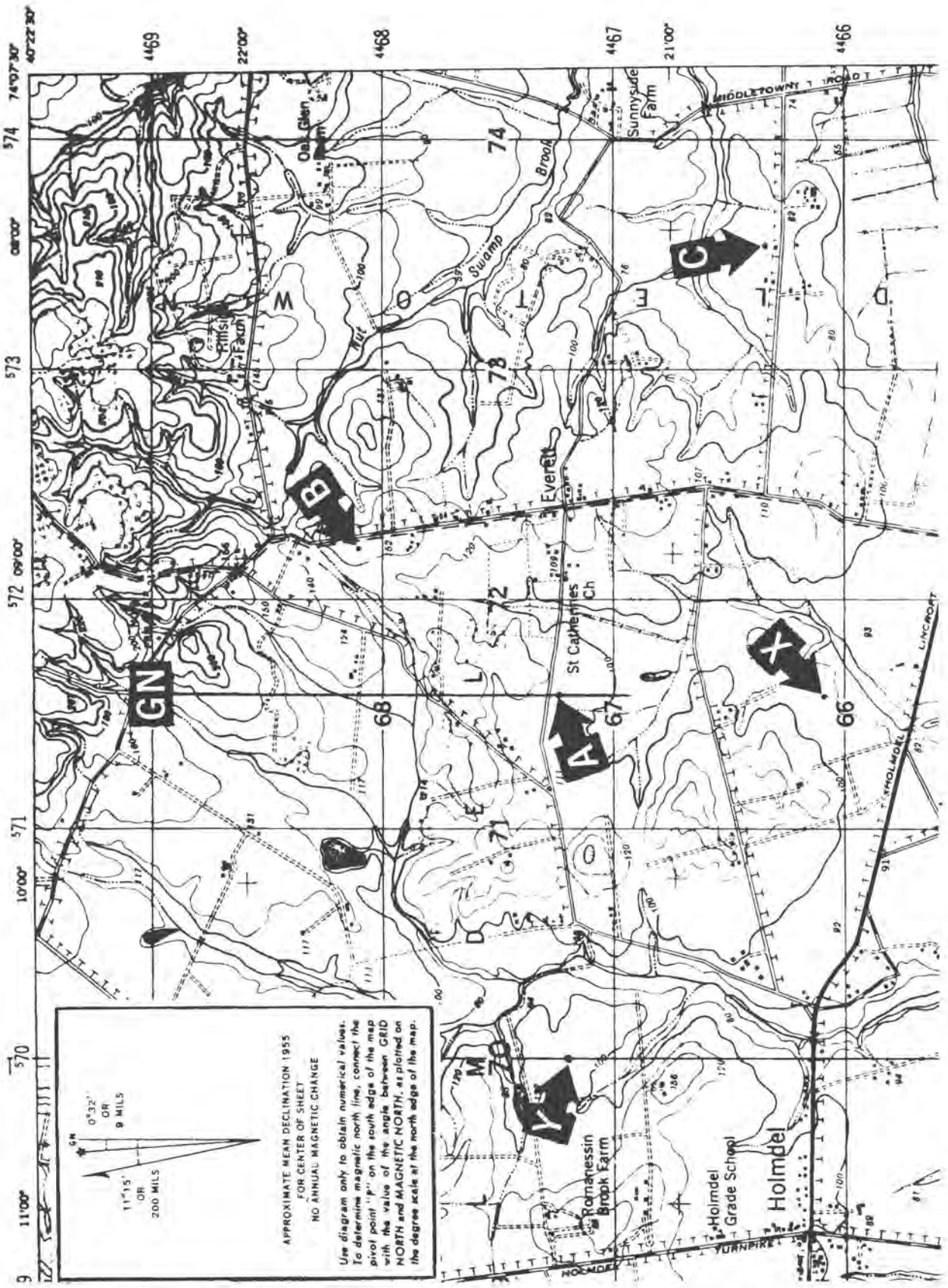


Figure 13. Map segment for use with frames 31-39 of Program 4.

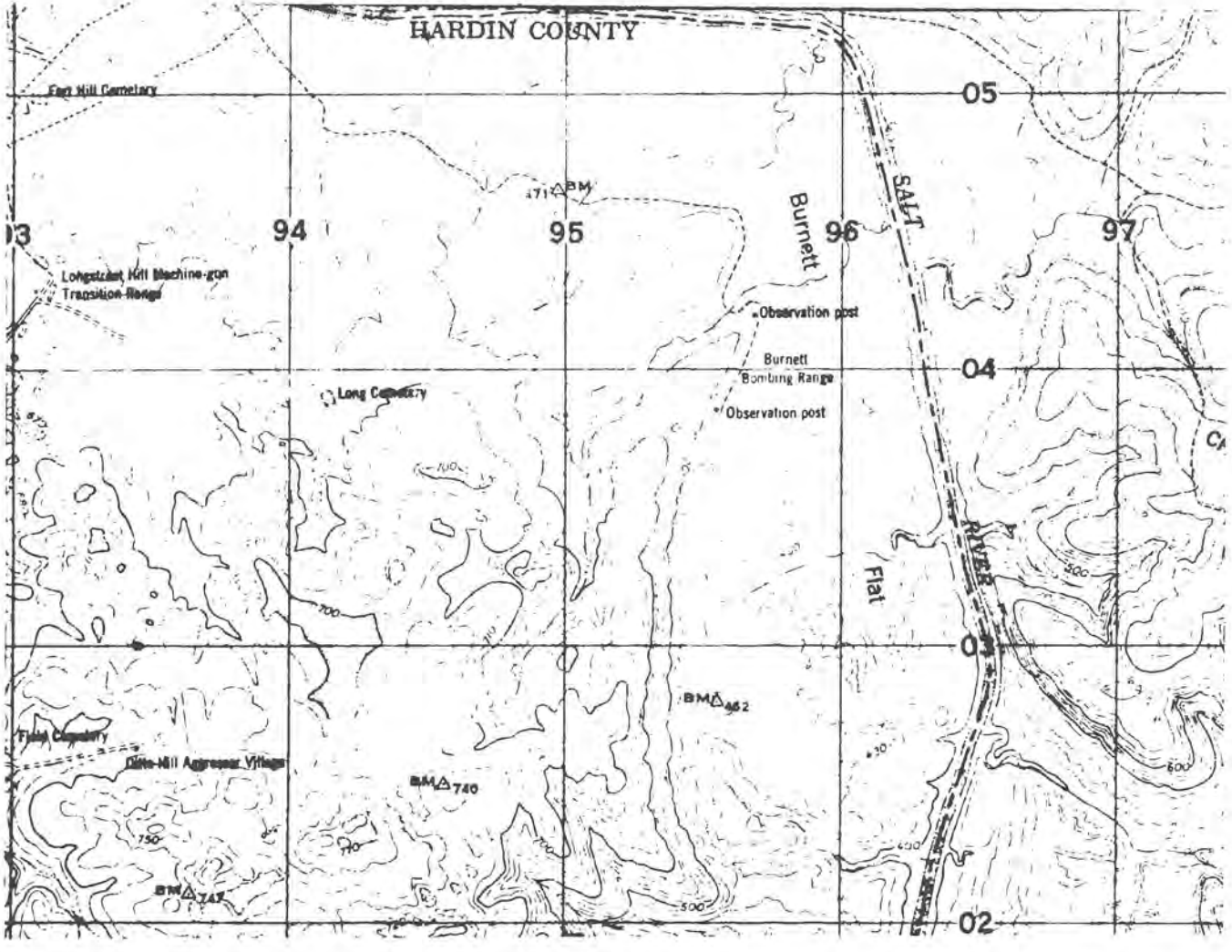


Figure 14. Map segment for use with frames 40-45 of Program 4.

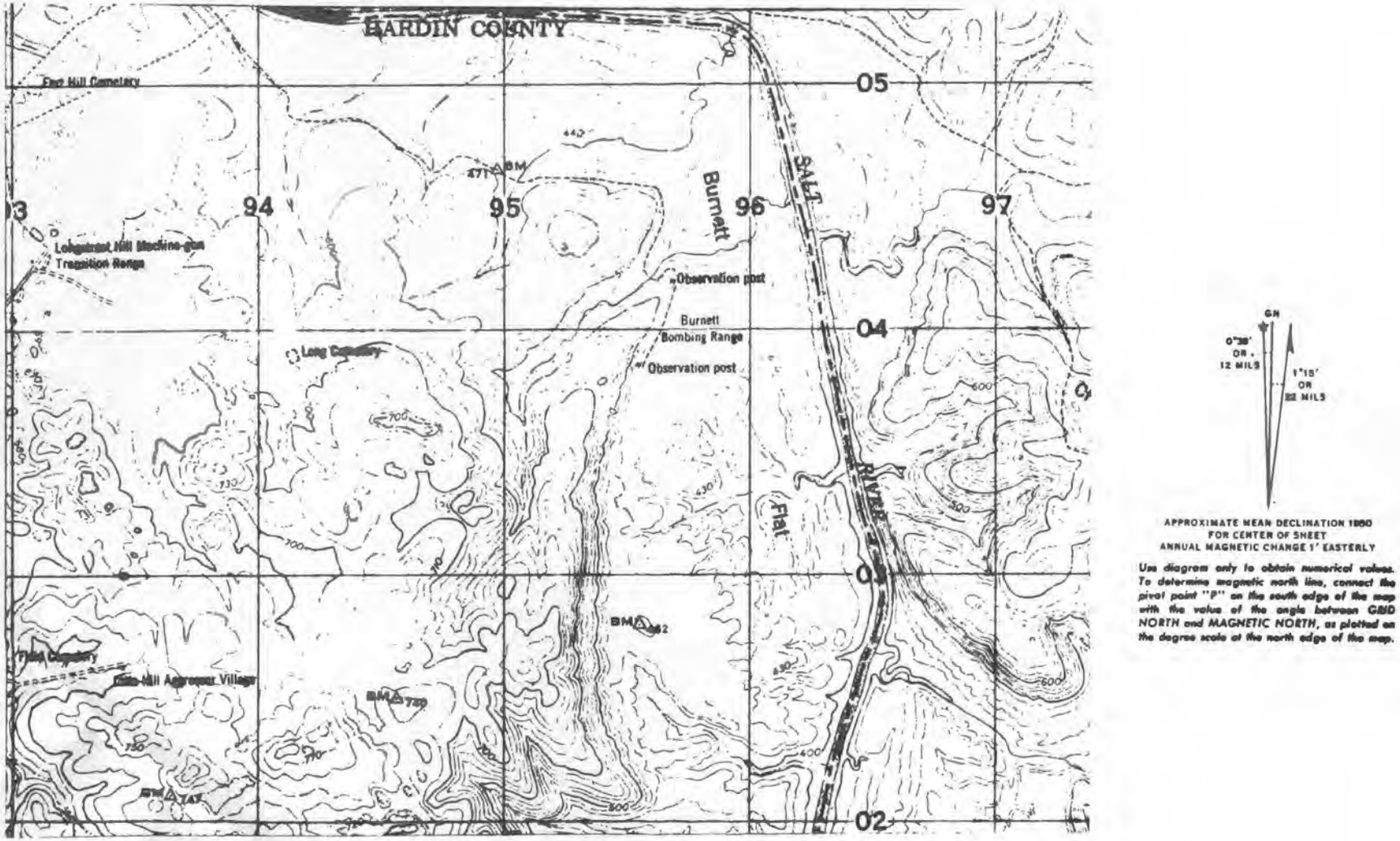


Figure 15. Map segment for use with frames 46-53 of Program 4.

ARMY
EXTENSION COURSE

AVIATION SUBCOURSE 75
MAP READING

PROGRAM 5
ORIENTING A MAP

UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA
MAY 1966

INTRODUCTION

In considering the overall picture of the terrain that a military map represents, you should keep in mind that the top of the map always represents the general direction of north. To use a map effectively in the field, it must be oriented, that is, the position of the map as you use it must be aligned with north. After a map is properly oriented, surrounding terrain features will appear in the same relative positions and distances as they appear on the map.

Note. You will need a lensatic compass and a straightedge to complete Program 5. A compass should be available in your unit supply room. If you are unable to obtain one, this will not preclude your learning the basic principles involved.

TO USE THE ILLUSTRATIONS CONVENIENTLY, REMOVE THEM FROM THE REAR OF THIS BOOKLET.

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Illustrations

Figure 16.	Reduced outline of Long Branch map sheet showing how to orient a map using a compass	15
Figure 17.	Reduced outline of Fort Knox map sheet	17
Figure 18.	Orienting a map by visual inspection	19

1. The top of a military map always represents the general direction of _____.

TURN PAGE

8. After the compass has been positioned on the map as in A of figure 16, you would then adjust the position of the map until it is properly _____.

15. When a compass is not available, you can orient a map as shown in figure 18 by _____ inspection.

1. north.

8. oriented.

15. visual

2. When you hold a map in the proper position for reading, the top of the map -- (select one response)

a. Shows the true direction of north.

b. Shows a general direction of north that will be an actual direction after the map is oriented.

9. To orient a map as shown in A of figure 16, you would adjust the position of the map until the compass needle indicates (0°) (11° 45') (348° 15').

KEY FRAME

16. Orientation of a map by visual inspection is recommended only when a _____ is not available.

2. b.

9. (0°)

16. compass

3. Figure 16 shows the methods you can use to orient a map using a compass. Part A on the right-hand side of the figure shows the _____ method of orientation; part B of the figure shows an _____ _____.

10. To orient a map as shown in B of figure 16 you would adjust the position of the map until the compass needle indicates (0^{O}) $(11^{O}\ 45')$ $(348^{O}\ 15')$.

KEY FRAME

17. In orienting a map by visual inspection, you would select linear features such as railroads, stream beds, and roads in preference to features such as water towers, buildings, etc. (true or false) _____

3. preferred

alternate method

10. (348° 15').

17. true

4. In the preferred method of orientation as shown in A of figure 16, the magnetic north base line is plotted on the map between pivot point P and the appropriate GM angle mark on the _____ _____ on the map sheet.

11. Now refer to figure 17. Use the declination diagram on the figure to determine the GM angle for 1963. The GM angle is ____ ____.

18. Figure 18 shows that to orient a map by visual inspection, the map is adjusted until the linear features observed appear in the same relative _____ on the map as they appear on the _____.

4. degree scale.

11. 1^{o} 28'

18. positions (locations, places, or the like.)

ground (terrain, land, or the like.)

5. In both A and B of figure 16, the GM angle of 11^{o} 45' was used because the declination diagram states that there is no annual _____ _____.

12. Draw the magnetic north base line on figure 17 from pivot point P to 1^{o} 28' on the degree scale.

19. On figure 18, prominent features A and B can be observed from the direction as indicated by the observer in the figure and from the opposite direction. If only A and B are used for orientation, the "orientation" might be _____.

5. magnetic change.

12. Go to frame 13.

19. reversed (opposite, backwards, or the like.)

6. On maps that include an annual magnetic change, before the magnetic north base line is plotted, you have to adjust the ____ ____ angle.

13. Open your compass and position it on the magnetic north base line on figure 17: adjust the position of the figure until the compass indicates that the figure is oriented. Refer to figure 16 as required.

KEY FRAME

20. If the observer in figure 18 knows his location on the map, the features A and B could be used for proper orientation of the map. (true or false) _____

6. G M

13. When orienting a map by using a compass and a magnetic north base line, the compass will indicate 0^{o} (magnetic north) when the map is oriented.

20. true.

(Providing the observer knows his location and thus knows from which direction he is looking at A and B.)

7. Notice the difference in positioning the compass on the map in figure 16. In part A, the compass sighting bar is aligned with the _____ _____ base line; in part B, the sighting bar is aligned with a vertical _____ _____.

14. Now hold figure 17 in its oriented position and position the compass on a vertical grid line to check the orientation. Is the angle indicated by the compass the same as the GM angle of 1^{o} 28' used to draw the magnetic north base line? (yes or no) ____

KEY FRAME

21. Complete the following general rules that apply to orienting a map by visual inspection.

a. Orient a map by visual inspection only when a _____ is not available.

b. When orienting a map by visual inspection, select _____ terrain features.

c. Non-linear terrain features such as buildings and towers can be used to orient a map by visual inspection only if the observer knows his _____ on the map.

KEY FRAME

7. magnetic north

grid line.

TURN TO PAGE 1
FRAME 8

14. Note that figure 17 is a reduced outline of the Fort Knox area map sheet. If you are orienting the figure in the Fort Knox area in 1963, your response should be YES. After 1963, the GM angle increases by 1 minute per year. If you are orienting the figure in a location other than that covered by the Fort Knox map sheet, the GM angle will vary by an amount that depends on your location and your answer should be NO.

TURN TO PAGE 1
FRAME 15

21. compass

linear

location

NOTES:

1. USE THE FOLLOWING PROCEDURE FOR ORIENTING A MAP BY THE PREFERRED METHOD.

   a. CONNECT PIVOT POINT P AND THE APPROPRIATE ANGLE MARKING ON THE DEGREE SCALE WITH A MAGNETIC NORTH BASE LINE AS STATED IN THE DECLINATION DIAGRAM ON THE MAP (A BELOW).

   b. OPEN THE COMPASS AND PLACE IT WITH ITS SIGHTING BAR ALIGNED WITH THE MAGNETIC NORTH BASE LINE.

   c. ADJUST THE POSITION OF THE MAP UNTIL THE COMPASS NEEDLE IS ALIGNED WITH THE MAGNETIC NORTH BASE LINE.

2. THE ALTERNATE METHOD (B BELOW) CAN BE USED TO ORIENT MAPS THAT DO NOT INCLUDE A DEGREE SCALE AND PIVOT POINT. THE MAGNETIC NORTH BASE LINE IS NOT NECESSARILY PLOTTED ON THE MAP. THE COMPASS AND VERTICAL GRID LINE ARE USED AS STATED.

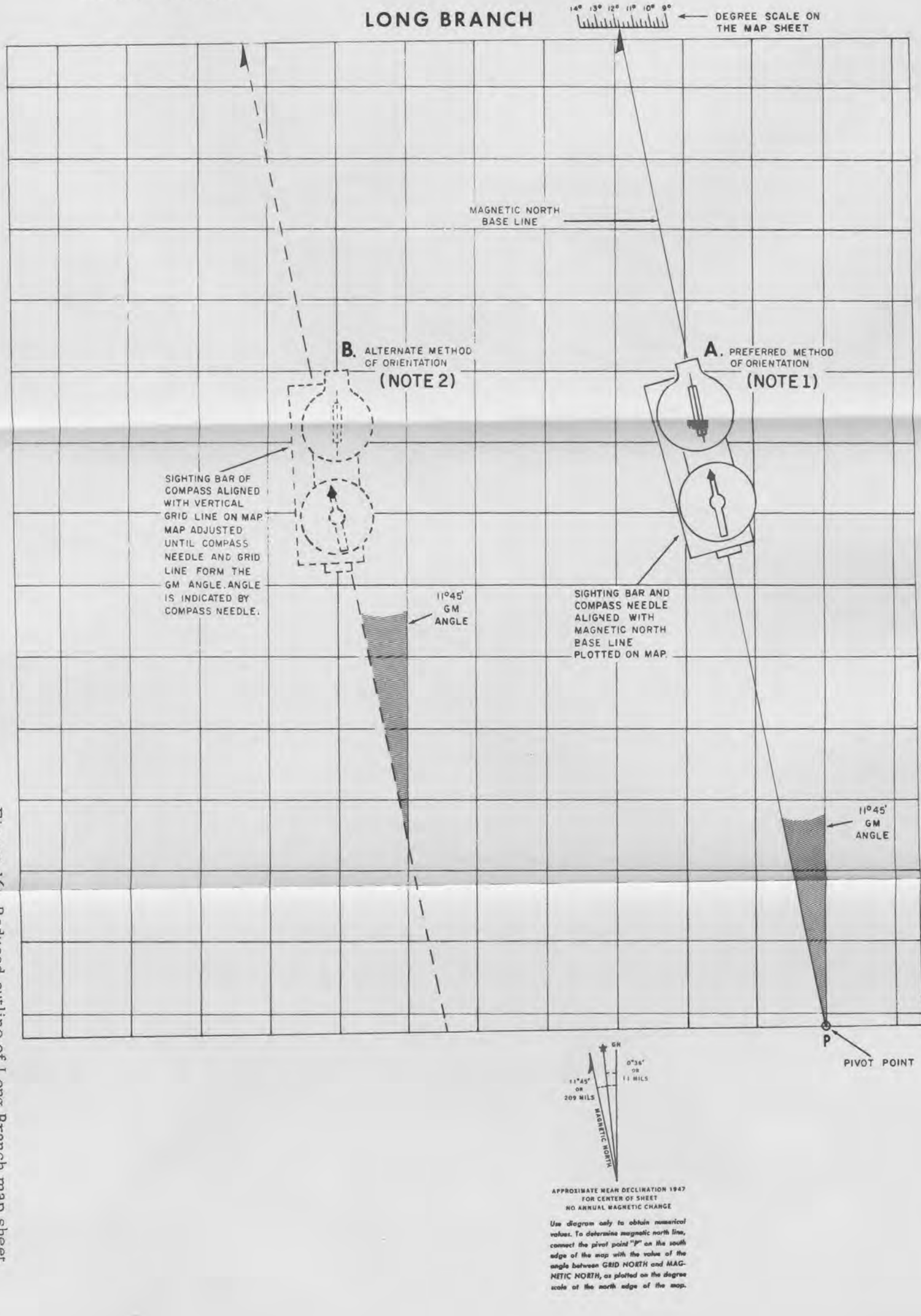

Figure 16. Reduced outline of Long Branch map sheet showing how to orient a map using a compass.

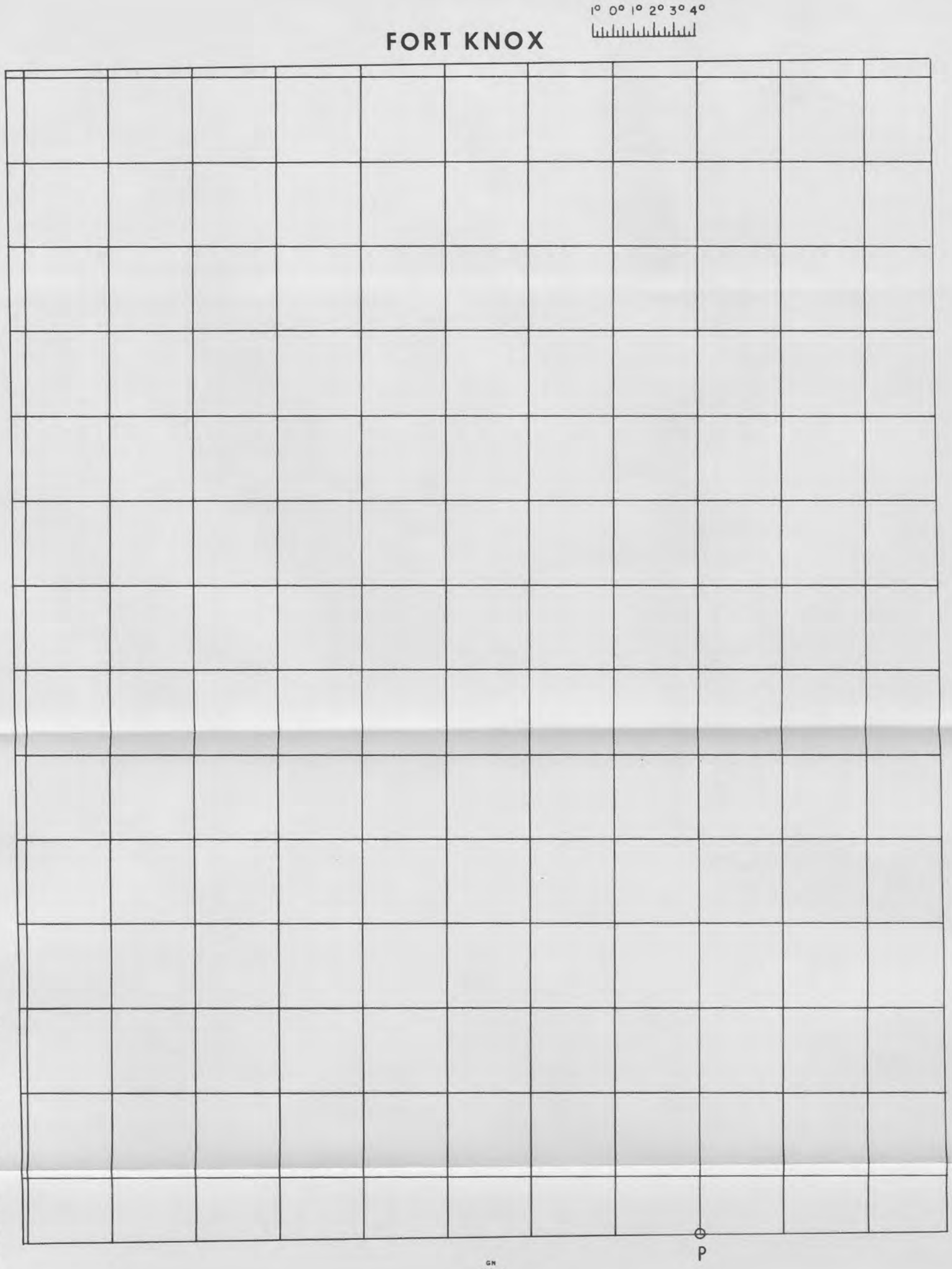

Figure 17. Reduced outline of Fort Knox map sheet.

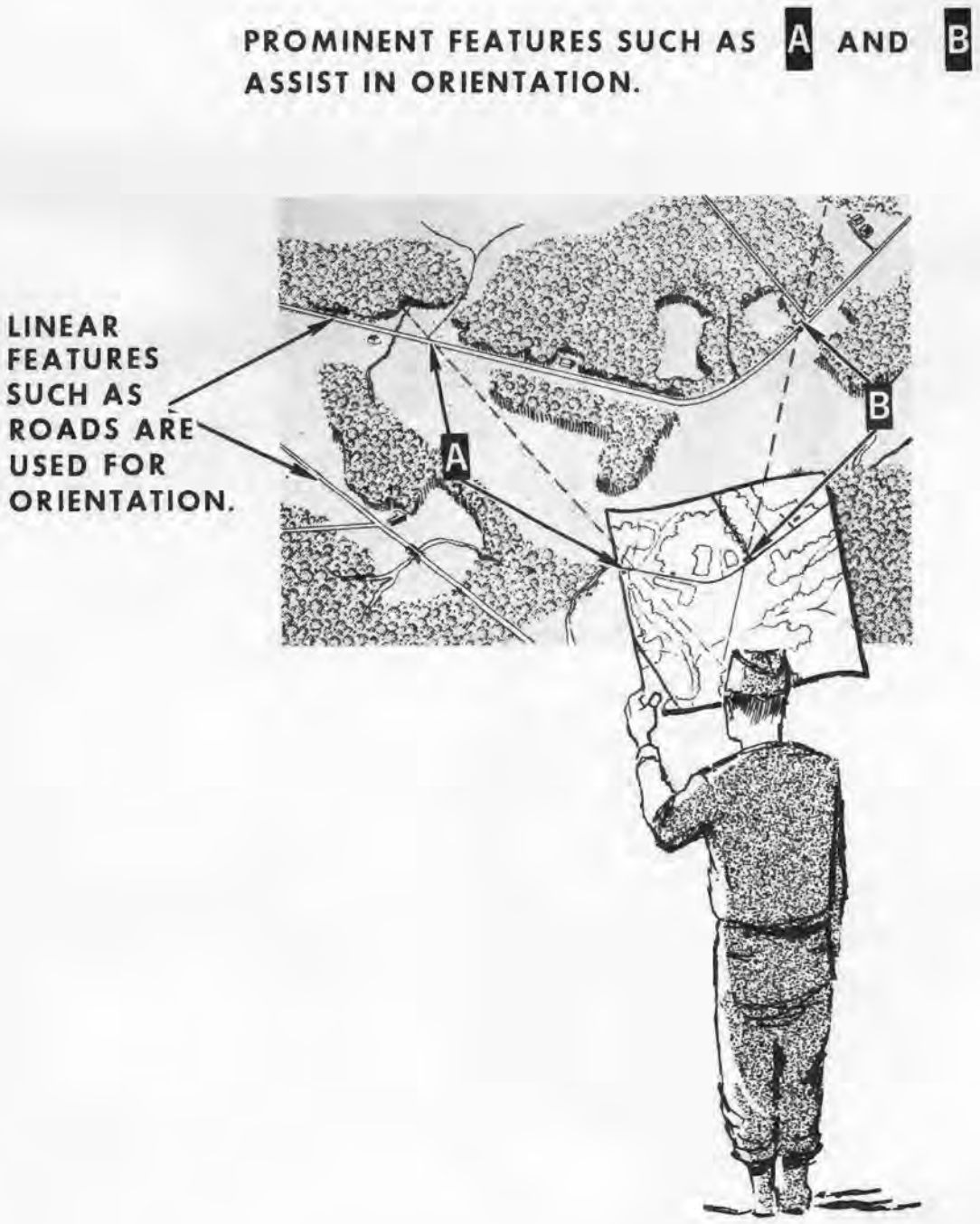

Figure 18. Orienting a map by visual inspection.

ARMY EXTENSION COURSE

AVIATION SUBCOURSE 75
MAP READING

PROGRAM 6
CONTOURS AND PROFILES

UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA

MAY 1966

INTRODUCTION

1. There are several methods used to indicate elevation and relief on a map; some of the more general methods are --

a. Layer tinting. Layer tinting is a method in which colors are used; each shade of color represents a definite elevation range. This system does not show exact elevations but simply indicates that the elevations are within the elevation range that the color represents.

b. Hachures. Hachures are short lines used to show relief both in conjunction with and independent of contour lines. Hachures do not represent exact elevations but are used to show relative slope in places where contours (or other methods) do not. An example of hachures combined with contour lines is included in the following frames where they are used to show depressions in the ground.

c. Form lines. A form line is a dashed line; it is not a contour line and is never labeled with representative elevation. Form lines do not necessarily connect points of equal elevation and are not measured from any base plane (such as sea level). A form line gives only a general idea of relief and may be used when information to produce more accurate results is not available. Form lines are normally used for making hasty maps or field sketches.

d. Shadow shading. Shadow shading indicates relief by a shadow effect achieved by darkening one side of hills, ridges, or mountains. The degree of slope is indicated by the intensity of shading.

2. Program 6, Contours and Profiles, covers the most commonly used and accurate method of showing elevation and relief on a map -- the contour line method. Contour lines show a vertical distance above or below a datum or reference plane, which is usually mean sea level. The vertical distance between contour lines is known as the contour interval; the amount of the contour interval is given in the marginal information on the map. Through the use of contour lines, a profile or side view of a straight line sector of terrain may be drawn.

Note: You will need a protractor, straightedge, and the map of Mineral Wells, Tex., 1:50,000, Sheet 6349 I, to complete Program 6.

TO USE THE ILLUSTRATIONS CONVENIENTLY, REMOVE THEM FROM THE REAR OF THIS BOOKLET.

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Figure 22. Profile sheet 2	35

1. Study figure 19. A contour line on a map connects all points that are at the same elevation _____ _____ _____.

TURN PAGE

16. The contour interval for K of figure 20 is _____ feet.

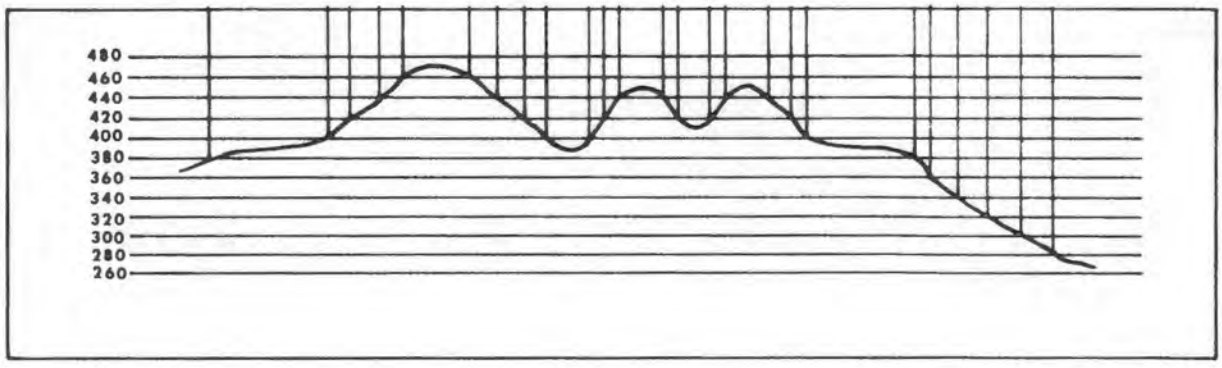
31. Now take figure 22, Profile sheet 2, place it on top of profile sheet 1 of figure 21 and complete steps 5, 6, and 7.

1. above sea level.

(A contour line on a map represents all points that are at the same elevation above sea level.)

16. 10 feet

31.



2. Contour lines on a map show the outline of land at the _____ _____ _____.

17. In figure 20, compare C and M to D and N. Widely-separated, evenly-spaced contour lines characterize a _____ slope or a _____. Contour lines that are close together and evenly-spaced characterize a _____ slope or a _____.

32. Notice the amount of exaggeration of the profile on figure 21 as compared to the same profile on figure 22. The amount of spacing between the horizontal lines on the profile sheet affects the amount of _____.

2. contour line level.

17. gentle;

valley;

steep;

draw

(Widely-separated, evenly-spaced contour lines characterize a gentle slope or a valley.)

(Contour lines that are close together and evenly-spaced characterize a steep slope or a draw.)

32. exaggeration

3. To determine the contour interval of a map, you would read the _____ _____ on the map.

18. In F of figure 20, the tick marks are used to show that the contour lines outline a _____.

33. If we were to draw a true profile of a terrain sector from a 1:50,000 map with a 20-foot contour interval, we would have to use a spacing of 0.0048 inch between the horizontal lines on the profile sheet. To avoid using such small values, map profiles are normally drawn as _____ profiles.

3. marginal information

18. depression

(Tick marks are used on a map to outline a depression.)

33. exaggerated

(Most profiles drawn from maps are exaggerated profiles.)

4. Compared to the intermediate contour lines as shown in figure 19, index contour lines appear (thicker and less frequently) (longer and more frequently.)

19. In E of figure 20, the absence of tick marks and the arrangement of the contour lines show that the terrain feature is a _____.

34. There are several implied facts which we have covered thus far that you should realize clearly. Recall that the profile line on figure 21 was drawn with a straightedge. The profile line, then, is a _____ line.

4. (thicker and less frequently)

19. hill

34. straight

5. Supplemental contour lines, as shown on figure 19, are used only where required for clarity. A supplemental contour line is drawn as a _____ line.

20. The chief difference between E and G of figure 20 is that the contour lines for a ridge are _____ and are roughly circular for a _____.

35. One fact that you should remember, then, is that we can draw a single profile only of terrain features that lie in a _____ line.

5. broken (dashed)

20. U-shaped

hill

35. straight

(In order to draw a profile, the terrain features to be profiled must lie in a straight line.)

6. Figure 19 shows that index and supplemental contour lines are normally shown with their numerical values. A numerical value must be determined for each _____ _____ _____.

21. In the spaces provided below, write the names of the contour shapes located at the following grid coordinates on your Mineral Wells map. The grid coordinates locate the approximate center of the contour shape. Use figure 20 as necessary to aid in identification.

A. 79253160 _____

B. 73303185 _____

C. 76902915 _____

KEY FRAME

36. To profile a terrain feature which contains a series of bends would require (one) (ten) (a series of) profiles.

6. intermediate contour line

21. A. Saddle

B. Cliff

C. Cut

36. (a series of)

7. On figure 19 for every 100 feet of elevation there are ____ (how many?) intermediate contour lines; the contour interval between each is _____ feet.

22. Locate hill 1183 in grid square 8343 of your Mineral Wells map. Considering just that portion of the hill in grid square 8343, which side of the hill has the steeper slope, the northern or the southern? _____

KEY FRAME

37. To profile a highway, railroad, or similar terrain feature that is not in a _____ line requires a _____ of profiles.

KEY FRAME

7. 4;

20 feet

22. Southern

37. straight;

series

8. The supplemental contour line on figure 19 is drawn at (1/2) (1/20) (1/10) of the contour interval. (Cross out inappropriate terms.)

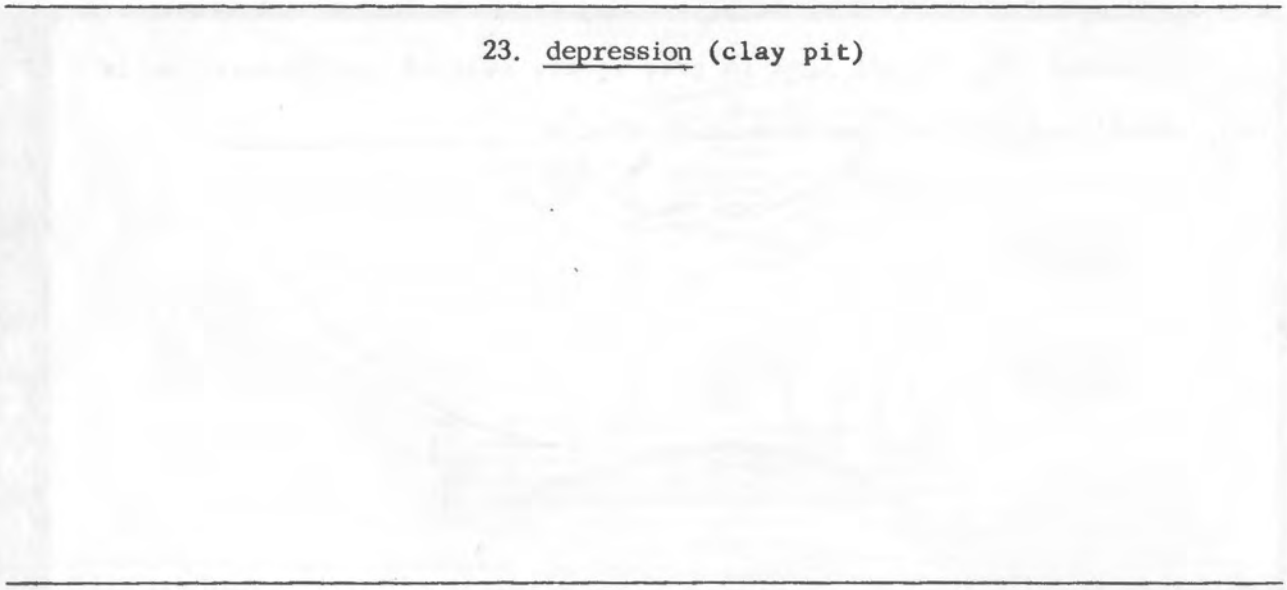
23. Locate the largest pond in grid square 8431 of your Mineral Wells map. On either side of the pond is located a _____.

KEY FRAME

38. Two other facts that you should be aware of concern the profile sheet as shown on figure 21. Note that the horizontal line on the profile sheet which corresponds to the highest value contour line is always placed (nearest to) (furthest from) the profile line.

8. (1/2)

23. depression (clay pit)



38. (nearest to)

9. Building A on figure 19 is 80 feet above sea level; building B is _____ feet above sea level.

24. Now refer to A of figure 20. The numerical values listed for each horizontal line of the profile correspond to the values of the _____ _____.

39. If the numbering sequence of the lines on the profile sheet of figure 21 were reversed, the profile would appear (higher) (upside down) (reversed end for end).

9. 40 feet

24. contour lines

39. (upside down)

10. You can closely approximate the elevation of a location between contour lines by the relative position of the location. In the spaces below, write the elevations of buildings C and D of figure 19.

Building C is at _____ feet.

Building D is at _____ feet.

25. Compare A and B of figure 20. On B of the figure, write in the contour line values that you would assign to the horizontal lines of the profile.

40. Take figure 22 and place it on figure 21 with the horizontal lines at approximately 30° to the profile line. If the profile sheet were used in this manner, the profile would be (shorter) (longer).

10. 50 feet;

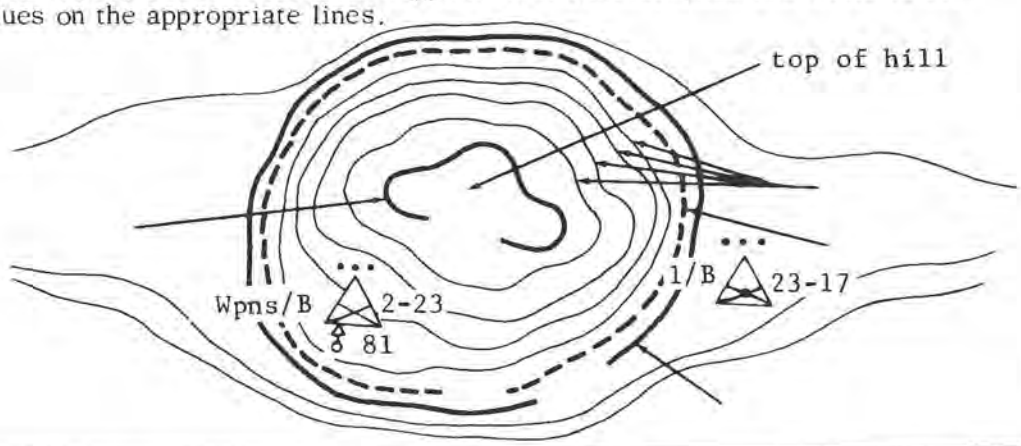
95 feet

25.

760
740
720
700
680
660
640
620
600
580

40. longer

11. In the sketch below, the highest and lowest values of the contour lines shown are 400 feet and 260 feet, respectively. Beside each arrow shown in the sketch, identify the lines as index, intermediate, or supplemental contour lines and write in the elevation values on the appropriate lines.



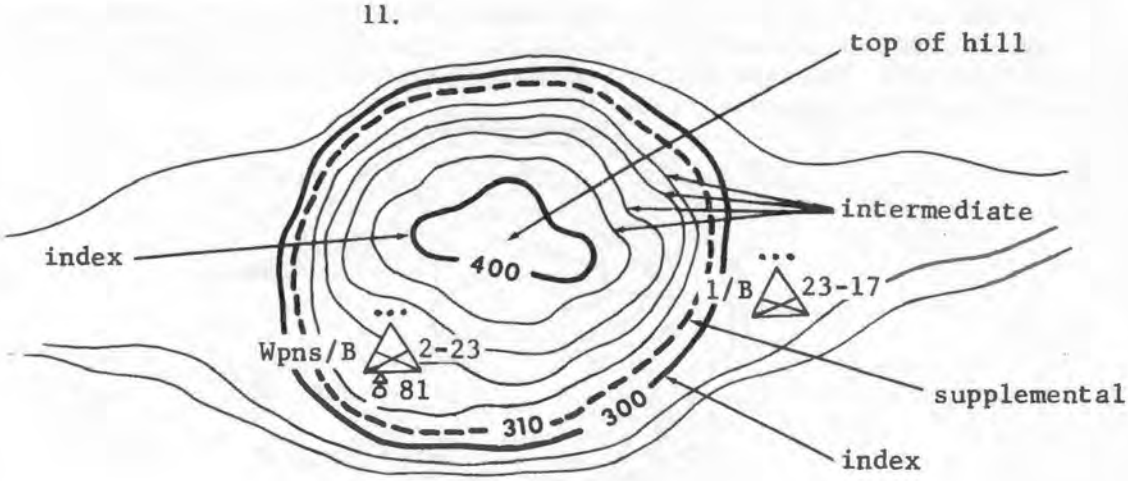
KEY FRAME

26. On figure 20, write in the contour line values that you would assign to the horizontal lines of the profiles in I, J, and L.

---

41. Try placing figure 22 with its lines at various angles, including 90^{O} and parallel to the profile line on figure 21. The best position for using the profile sheet is with the horizontal lines _____ to the profile line.

11.



26.

I	I	L
820	560	620
800	540	600
780	520	580
760	500	560
740	480	540
720	460	520
700	440	500
680	420	480
660	400	
640	380	

41. parallel

12. Look at the response for frame 11. What is the approximate elevation of the observation post of the Weapons Platoon, Company B, 2nd Battalion, 23rd Infantry? Use the approximate center of the symbol as its location.

_____ feet.

KEY FRAME

27. Compare A and G of figure 20. In the spaces below, list the items that are omitted on illustration G.

_____

_____ _____

_____ _____ _____

42. The profile sheet must be positioned with its horizontal lines _____ to the profile line and with the highest value line _____ to the profile line.

KEY FRAME

12. 340 feet

27. Perpendiculars;

Profile line;

Horizontal line numbers

42. parallel;

nearest (closest)

(The profile sheet must be used with its horizontal lines parallel to the profile line and with the highest value line nearest or closest to the profile line.)

13. Sometimes the exact elevations of hilltops and depression bottoms are stated on a map. When the elevations are not stated, they are generally determined by interpolation -- splitting the contour interval and adding it to (hills) or subtracting it from (depressions) the appropriate contour line value. The elevation of hilltop A below is 430 feet. What is the elevation of hilltop B?

_____ feet.

elevation= 420 + 10 = 430 feet

28. Use illustration H on figure 20 as a guide and write in the horizontal line numbers, then roughly sketch in the profile line and perpendiculars, in that order, on G of the figure.

43. Refer to figure 21. Draw perpendiculars to locate points X, Y, and Z on profile sheet 1. From point X can (write yes or no) --

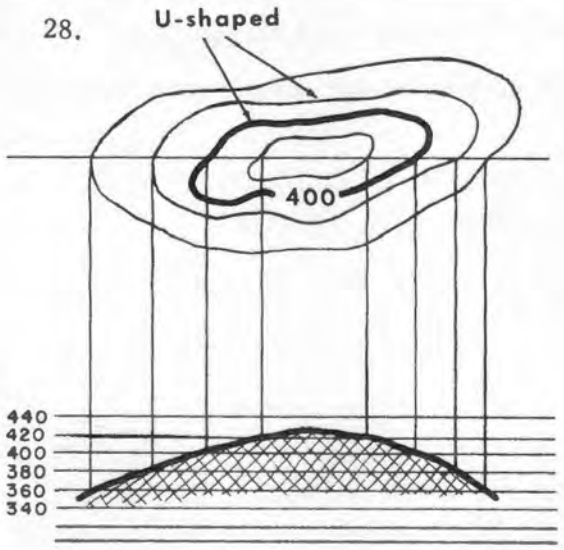
a. point Y be observed? _____

b. point Z be observed? _____

13. 250 feet

(Elevation of hilltop B = 240 + 10 = 250 feet)

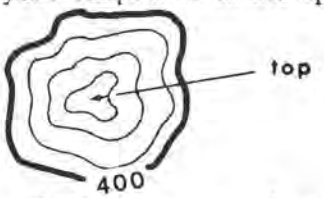
28.



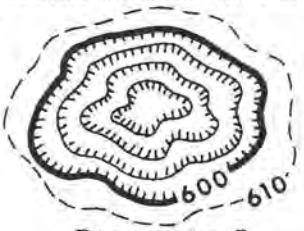
43. a. yes

b. no

14. Assuming a contour interval of 20 feet, interpolate, as necessary, to determine the elevations of the hilltops and depression bottoms in A through D below. Write your responses in the spaces provided.



Hill A = _____ feet



Depression B = _____ feet

Hill C = _____ feet

Hill D = _____ feet

KEY FRAME

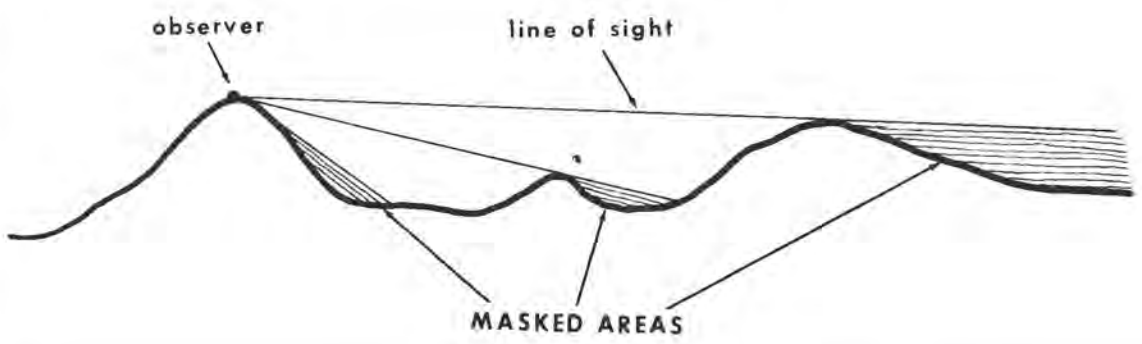
29. On figure 21, three of the contour shapes from figure 20 have been joined to form a small sector of terrain. In the spaces below, write the names of the contour shapes that appear on figure 21.

a. _____

b. _____

c. _____

44. The diagram below shows how areas that are masked or hidden from an observer's view can be determined from a profile. On profile sheet 1 of figure 21, determine the areas that are masked from an observer at point X.



KEY FRAME

14. Hill A = 470 feet;

Depression B = 530 feet;

Hill C = 526 feet;

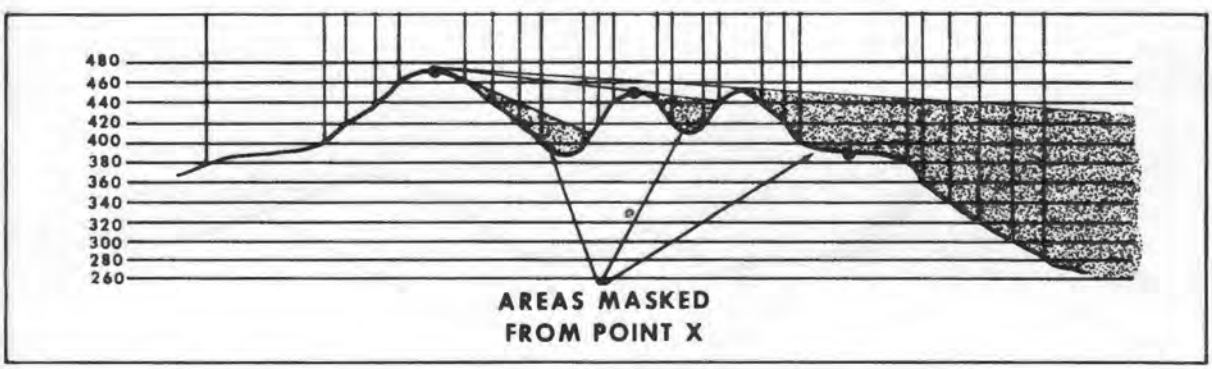
Hill D = 755 feet

29. a. Ridge;

b. Saddle;

c. Spur

44.



15. Now study illustrations A through N on figure 20 which show elevations in feet. Except for illustration K, what is the contour interval for the illustrations? _____ feet.

30. Notice that the steps for drawing a profile are briefly stated at the bottom of figure 21. Follow the encircled step numbers on the illustration and draw the profile of the terrain sector. Refer to A of figure 20 as a guide and use a protractor for drawing perpendiculars.

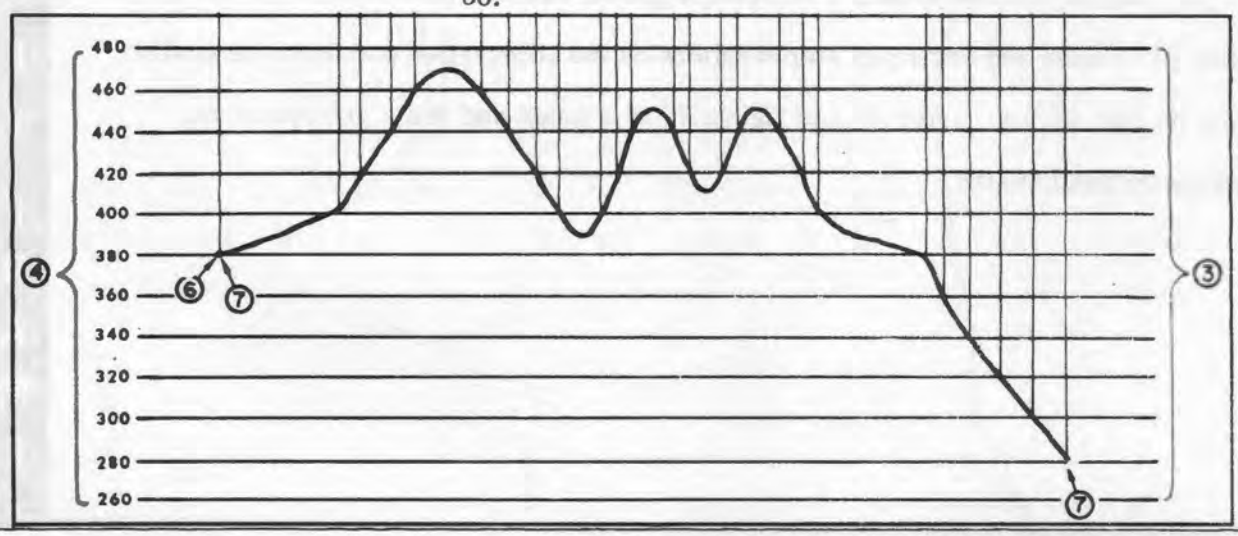
KEY FRAME

END OF PROGRAM 7

15. 20 feet

TURN TO PAGE 1
FRAME 16

30.



TURN TO PAGE 1
FRAME 31

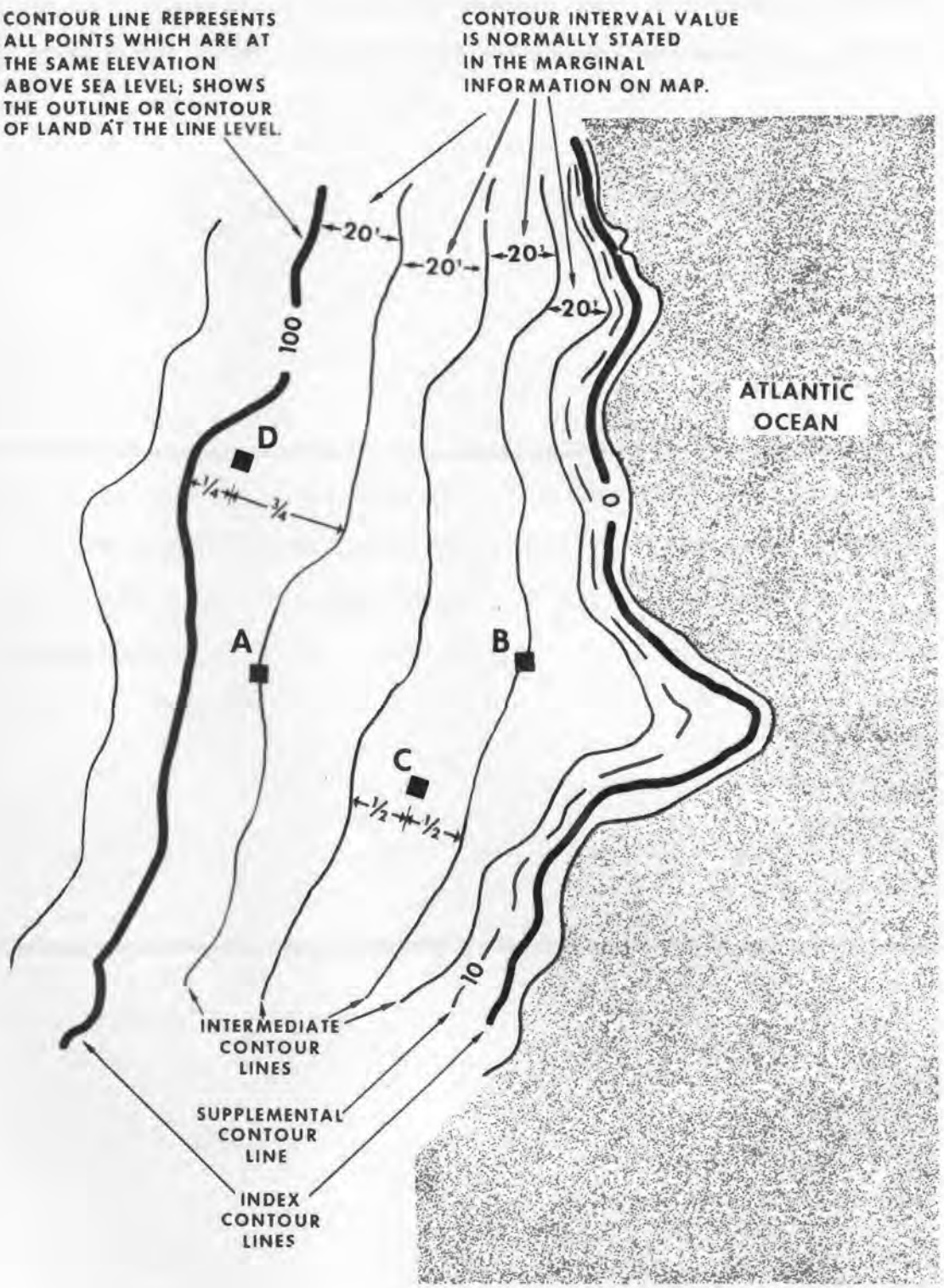
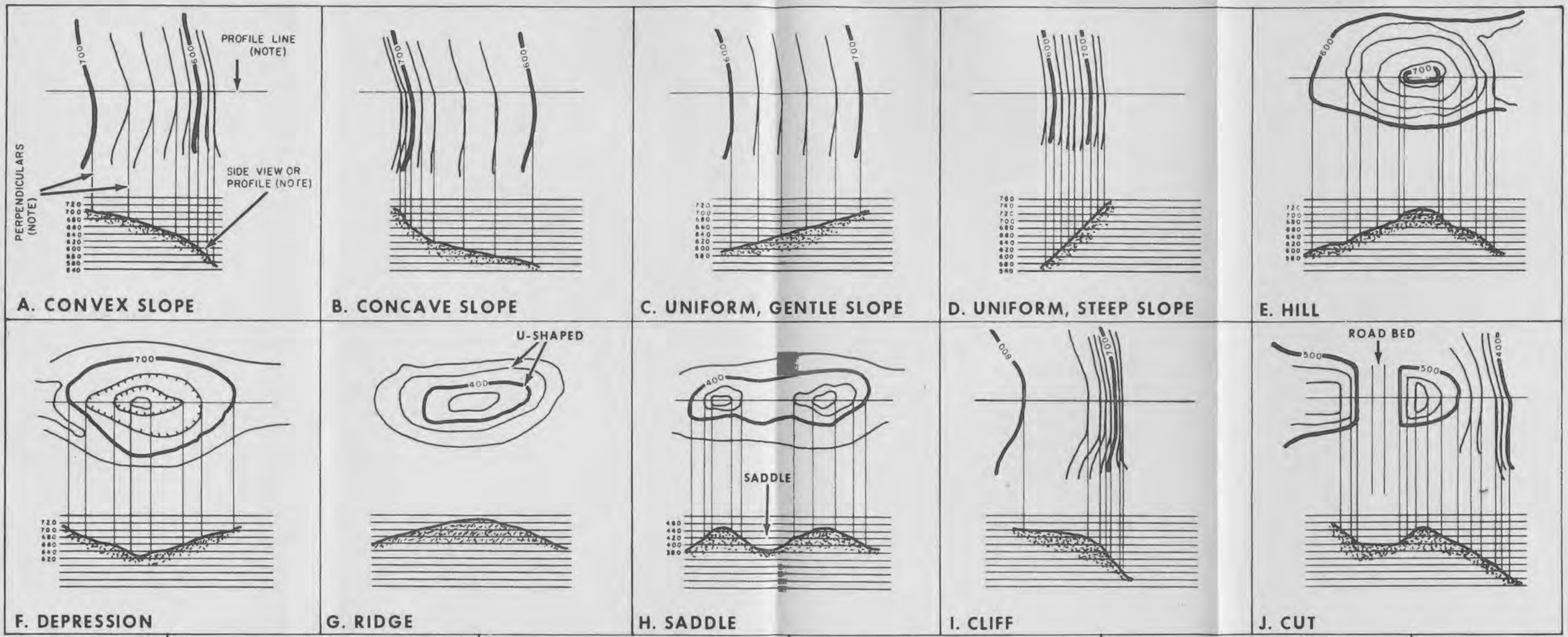


Figure 19. Types of contour lines.



NOTE: PROFILE LINE, PERPENDICULARS, AND PROFILES IN A THROUGH N DO NOT APPEAR ON MAPS.

Figure 20. Typical contour shapes.

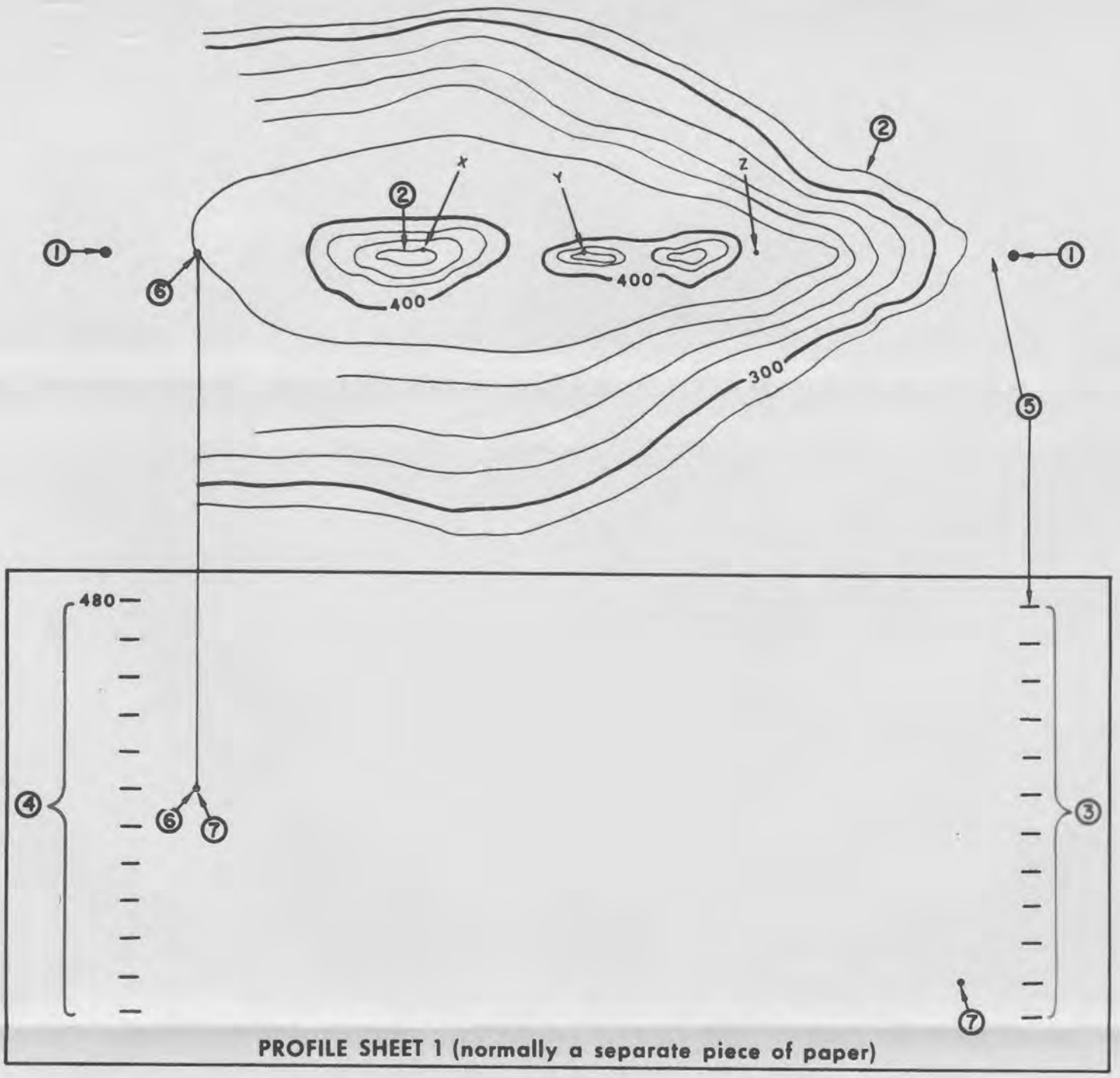


Figure 21. Terrain sector and profile sheet 1.

STEP	PROCEDURE
①	..... DRAW PROFILE LINE.
②	..... DETERMINE HIGHEST AND LOWEST ELEVATIONS.
③	..... PREPARE LINES ON PROFILE SHEET.
④	..... NUMBER THE LINES ON THE PROFILE SHEET.
⑤	..... POSITION PROFILE SHEET WITH LINES PARALLEL TO THE PROFILE LINE. (THIS IS ALREADY DONE FOR YOU ON THIS ILLUSTRATION.)
⑥	..... DRAW A PERPENDICULAR FROM EACH POINT OF INTERSECTION OF THE PROFILE LINE AND THE CONTOUR LINES TO THE APPROPRIATE VALUE LINE ON THE PROFILE SHEET.
⑦	..... DRAW THE PROFILE BY CONNECTING THE POINTS OF INTERSECTION OF THE PERPENDICULARS AND PROFILE SHEET LINES WITH A SMOOTH CURVE. DETERMINE HILLTOPS AND DEPRESSION BOTTOMS BY INTERPOLATION.

FT RUCKER 037699

TEAR ON THE DOTTED LINE

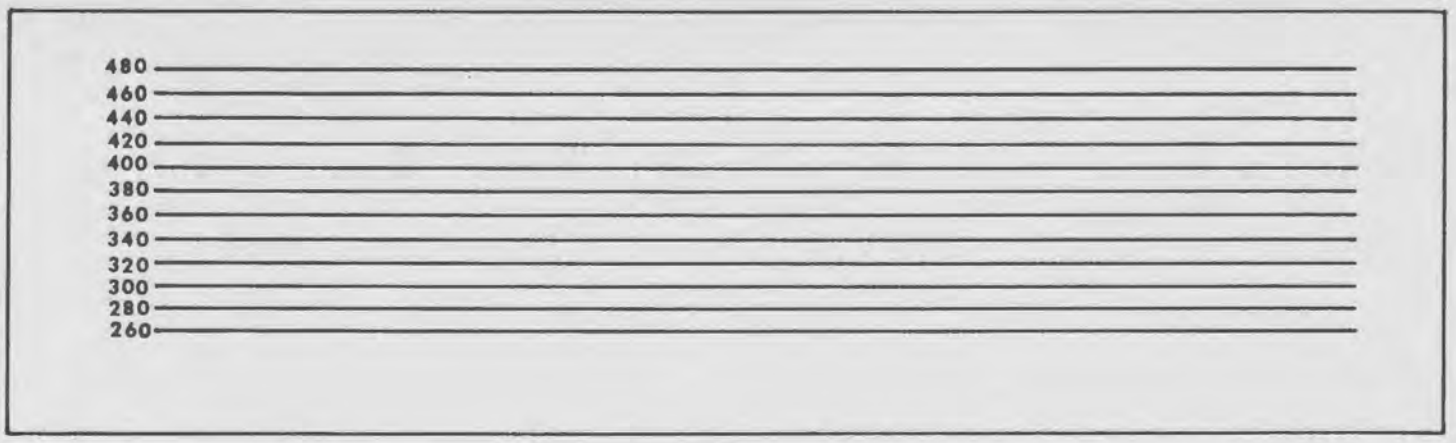


Figure 22. Profile sheet 2.

ARMY EXTENSION COURSE

AVIATION SUBCOURSE 75

MAP READING

PROGRAM 7
SLOPE

UNITED STATES ARMY AVIATION SCHOOL
FORT RUCKER, ALABAMA
MARCH 1967

INTRODUCTION

Program 7, Slope, covers the methods of determining slope - the rate of rise or fall of a ground form. Although a slope can be described as steep or gentle, the question arises as to how steep or how gentle. The slope of the ground determines whether or not you can land your aircraft. It affects the speed at which men and vehicular equipment can move, and, for most vehicular equipment, there is a maximum limit to the slope on which it can be used. Thus, whether you are flying a helicopter or fixed wing aircraft, moving equipment to a construction site, or directing a unit march, slope is an important planning consideration.

Note: You will not need any instruments to complete Program 7.

TO USE THE ILLUSTRATIONS CONVENIENTLY, REMOVE THEM FROM THE REAR OF THIS BOOKLET.

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1. The rate of rise or the rate of fall of a ground form is called _____

TURN PAGE

12. Convert the horizontal distance (533 yards) into feet. The horizontal distance is _____ feet.

23. Note that the response for frame 22 is plus ten percent (+10%). In going from X to Y on figure 23, you are proceeding on an upgrade, and you use a plus (+) sign to indicate this fact. If you were going from Y to X, you would be proceeding on a _____ and you would indicate this fact by a _____ (-) sign.

1. slope

12. 1,599 feet (round off to 1,600 feet)

23. downgrade;

minus

2. If the ground form is an upgrade, its slope tells you its rate of r_____

13. Notice that the distances involved in measurement of the ground form are always expressed in the same units of measurement If the vertical distance were expressed in meters, then you would express the horizontal distance in _____

24. Percent of slope, then, depends on the direction of travel. An upgrade is shown by using a _____ sign and a downgrade is shown by using a _____ sign.

2. rise

13. meters

24. plus;

minus

3. If the ground form is a downgrade, its slope tells you its rate of f_____.

14. The rule for measuring the vertical and horizontal distances required to determine slope is - Express measured values in the same _____ of measurement.

KEY FRAME

25. On figure 23, the percent of slope from point D (use elevation of 820 feet for point D) to point E is _____.

KEY FRAME

3. fall

14. units

25. -14.2%

4. When you determine the slope of a ground form, you determine its rate of

_____ or _____

KEY FRAME

15. One way of expressing slope is by a simple fraction, called the GRADIENT of slope, that compares the vertical distance (VD) to the horizontal distance (HD). We can write this comparison as a formula --

$$\text{GRADIENT} = \frac{VD}{\quad}$$

_____(supply the missing term)

26. The percent of slope from point E to point D on figure 23 is _____

KEY FRAME

4. rise or fall

15. HD (or horizontal distance)

26. +14.2%

INFORMATION FRAME

5. The slope of a ground form can be determined from a map by comparing its VERTICAL DISTANCE (height or depth) to its HORIZONTAL DISTANCE (breadth).

16. In the space below, write the formula for GRADIENT of slope and determine the gradient between points X and Y on figure 23 (VD = 160 feet; HD = 1,600 feet). Reduce the gradient fraction to its lowest terms.

KEY FRAME

27. The two ways of expressing slope that you have covered so far are gradient and percent of slope. Slope is normally expressed in _____

5. Go to frame 6.

16. GRADIENT = $\frac{VD}{HD} = \frac{160\text{ ft}}{1{,}600\text{ ft}} = \frac{1}{10}$

27. <u>percent</u>

6. The difference in elevation between the highest and lowest points on a ground form is its V_____ D_____(VD).

17. When referred to the distance from X to Y on figure 23, the gradient 1/10 tells us that for each 10 feet of horizontal distance, the upgrade is _____.

INFORMATION FRAME

28. Slope can also be expressed as degrees of slope and as mils of slope. Note the change in the multiplier in the following formulas.

$$\text{Degrees of slope} = \frac{VD}{HD} \times 57.3$$

$$\text{Mils of slope} = \frac{VD}{HD} \times 1{,}000$$

6. VERTICAL DISTANCE

17. 1 foot

28. Go to frame 29.

7. By using the contour lines on a map, you can determine the _____ _____ of a ground form.

18. When referred to the distance from Y to X on figure 23, the gradient 1/10 tells us that for each 10 feet of horizontal distance, the _____ is _____ foot.

29. Draw a circle around the correct multiplier in each of the following:

Gradient of slope = $\frac{VD}{HD}$ x (none) (100)(57.3) (1,000)

Percent of slope = $\frac{VD}{HD}$ x (none) (100) (57.3) (1,000)

Degrees of slope = $\frac{VD}{HD}$ x (none) (100) (57.3) (1,000)

Mils of slope = $\frac{VD}{HD}$ x (none) (100) (57.3) (1,000)

KEY FRAME

7. vertical distance (or abbreviation VD)

18. downgrade is 1 foot

29. (none);

(100)

(57.3);

(1,000)

8 Look at figure 23. The vertical distance of the portion of the trail marked from X to Y is _____ feet.

KEY FRAME

19. Refer to figure 23. Using 20 feet as the contour interval, determine the gradient of slope of hill AB from Bench mark BM 462. The gradient of slope is _____

KEY FRAME

30. There is one more point you should know about the slope formulas -- the multiplier 57.3 should be used only for angles less than 20 degrees. This affects only the formula for finding _____ of slope.

8. 160 feet

19. 1/5.8 (1/6 approximate)

30. degrees

9. The distance measured along the ground, or scaled from a map, from the highest to the lowest points on a ground form is its H _____ D _____

20. Slope is normally expressed in percent. To change a fractional value, such as .VD/HD, to percent, you would multiply by (10) (100) (1,000).

31. Remember, too, that after you determine slope either in degrees, mils, gradient, or percent, to show that the slope is an upgrade you use a _____ sign and, a _____ sign to show a _____ _____.

9. HORIZONTAL DISTANCE

20. (100)

31. plus;

minus;

downgrade

10. By using the bar scales on a map, you can determine the _____ _____ of a ground form.

21. Using the fraction VD/HD, complete the formula for percent of slope in the space below.

Percent of slope = _____

32. Now refer to figure 24. Determine the percent of slope from P1 to P2 along HIGHWAY 180.

KEY FRAME

10. horizontal distance

21. Percent of slope = $\frac{VD}{HD} \times 100$

32. Percent of slope = $\frac{VD}{HD} \times 100$

$= \frac{140}{3750} \times 100$

$= \frac{14}{15} \times 4$

$= .933 \times 4$

$= 3.732$ or -4%

11. On figure 23, the horizontal distance of the portion of the trail marked from X to Y, scaled with the yards bar scale, is approximately _____ yards.

KEY FRAME

22. Using VD = 160 feet and HD = 1,600 feet, determine the percent of slope for the portion of the trail from X to Y on figure 23.

KEY FRAME

33. The percent of slope from P2 to P1 on figure 24 is _____.

KEY FRAME

11. 530 yards (use 533 yards)

TURN TO PAGE 1
FRAME 12

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22. +10%

$$\text{Percent of slope} = \frac{VD}{HD} \times 100$$

$$= \frac{160}{1600} \times 100$$

$$= \frac{16}{160} \times 100$$

$$= \frac{1600}{160}$$

$$= 10\%$$

TURN TO PAGE 1
FRAME 23

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33. +4%

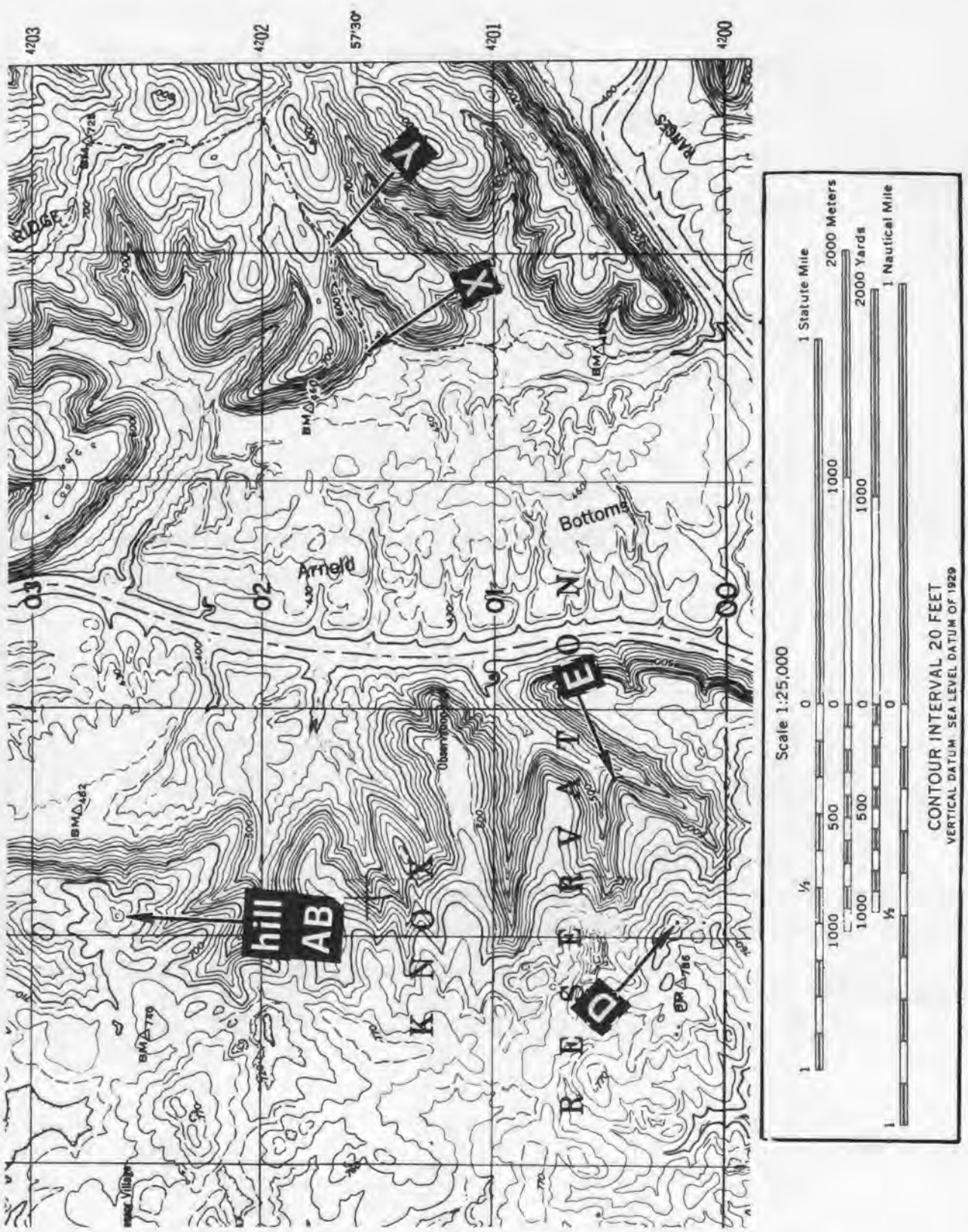
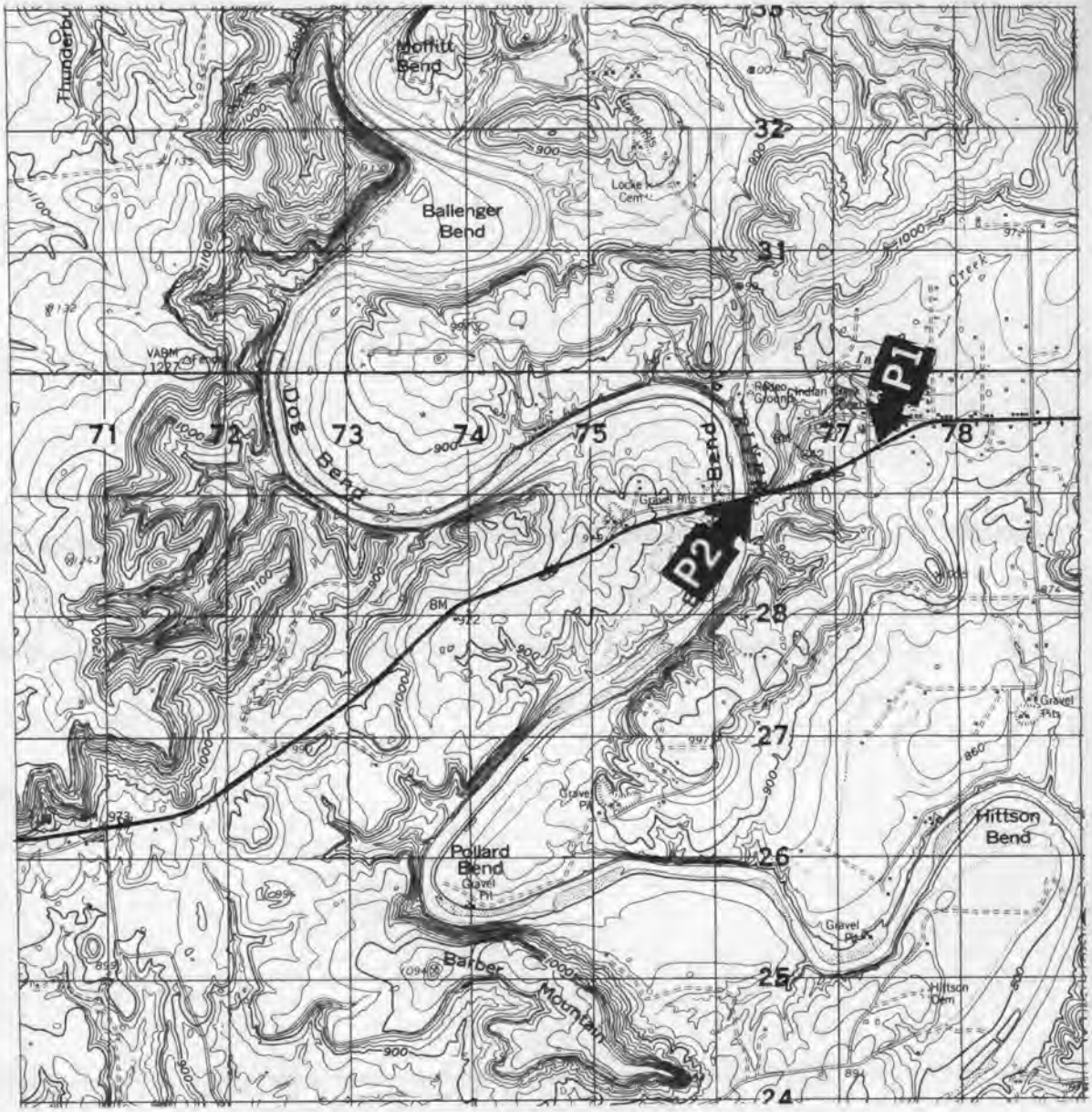


Figure 23. Map segment used with frames 8-26 of Program 7.



BAR SCALES

Scale 1:50,000

1 ½ 0 1 2 3 Statute Miles

1000 500 0 1000 2000 3000 4000 Meters

1000 500 0 1000 2000 3000 4000 Yards

1 ½ 0 1 2 3 Nautical Miles

CONTOUR INTERVAL 20 FEET
WITH SUPPLEMENTARY CONTOURS AT 10 FOOT INTERVALS
VERTICAL DATUM: SEA LEVEL DATUM OF 1929

Figure 24. Map segment used with frames 32 and 33 of Program 7.