Performance Objective 4: Map and Compass

Enabling Objectives:

1. **Measure a grid bearing.**
2. **Measure a Magnetic Bearing.**
3. **Navigating at Night.**

Review

1. Care of Maps. Ways to protect your map:

   a. Place your map in a clear plastic bag, or permanently laminate it;

   b. Fold it properly and refold it only along the original fold lines to view other parts;

   c. If it gets wet, dry it on a flat, clean surface;

   d. Don’t open it fully in a strong wind;

   e. Use only pencil to mark your map and erase all markings gently—maps protected by plastic can be marked using grease pencils or erasable markers; and,

   f. Store maps in a dry place, rolled, folded or laid flat.

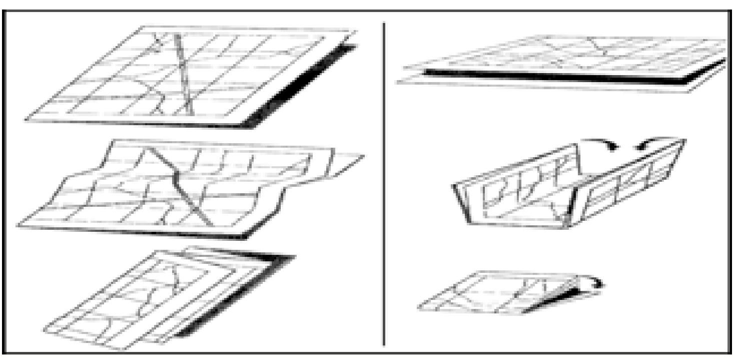


Figure 4-1

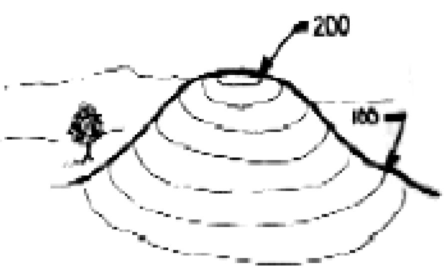
2. Topographical Maps. A topographical map illustrates water features, vegetation, elevation and depression, wetlands, urban development, transportation and communication routes (roads, railways, telephone lines, etc.), structures, natural features and place names 1:50,000- or 1:250,000-scale topographical maps are produced of all areas of the United States by the federal government. The information is stored in the National Topographical Data Base as part of the National Topographical System (NTS). The mapping information is based on the North American Datum of 1983 (NAD 83).

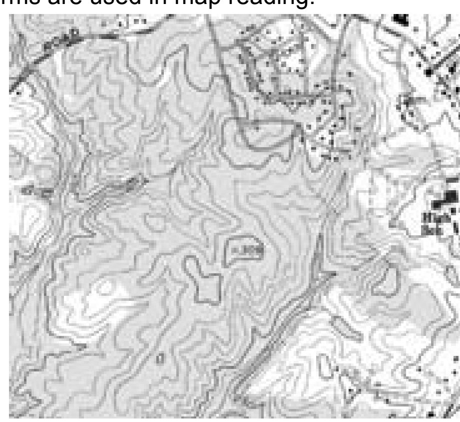
3. Conventional Signs. The five basic colors of a topographical map are:

a. Red—is used for paved roads and highway numbers—it is also used to shade in areas of urban development;
b. Brown—is used for contour lines, contour elevations, spot elevations, sand, cliffs, and other geological features;
c. Blue—is used for water or permanent ice features (like rivers, lakes, swamps and ice fields), names of water features, and the grid lines;
d. Green—is used for vegetation features like woods, orchards and vineyards;
e. Black—is used for cultural features (buildings, railways, transmission lines, etc.), toponymy (place names), some symbols and precise elevations.

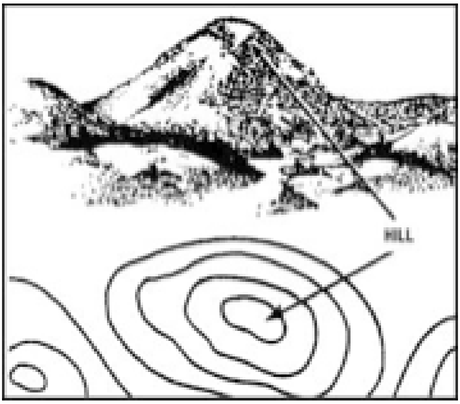
Figure 4-2

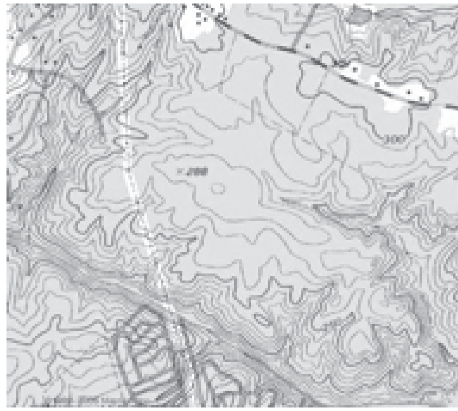
4. Map and Compass Terms. The following terms are used in map reading:



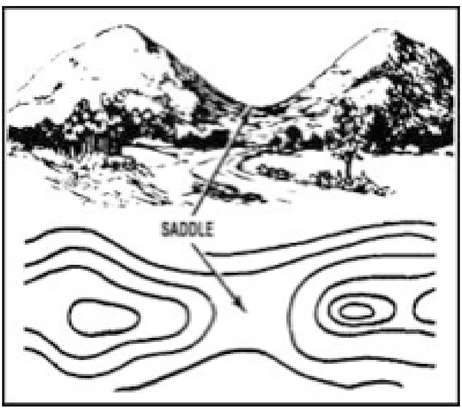


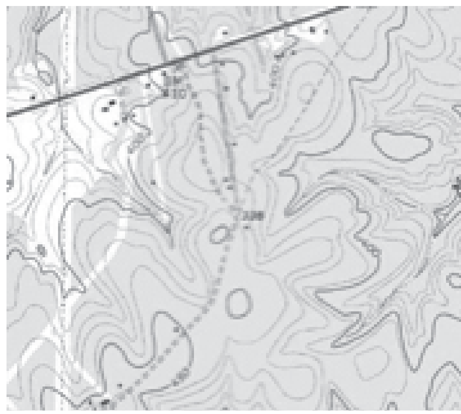
a. Contour line – A contour line is a line on the map joining points of equal elevation above sea level. Contour lines are drawn on maps to give you a three-dimensional view of the ground.



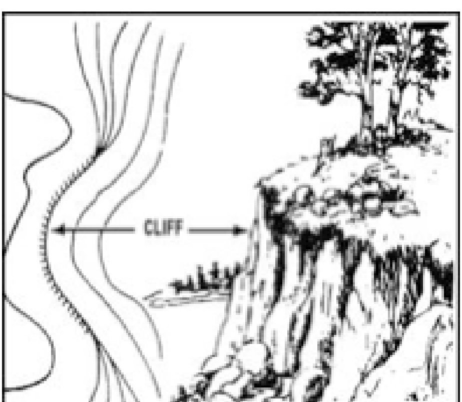


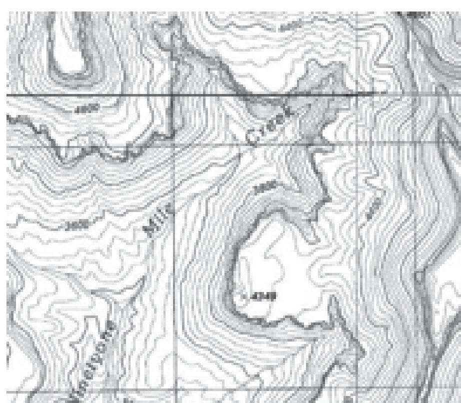
b. Hill – A hill is a point or small area of high ground. When you are located on a hilltop the ground slopes down in all directions. A hill is shown on a map by a number of closed contour lines.



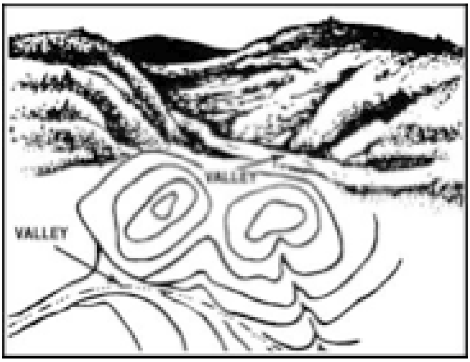


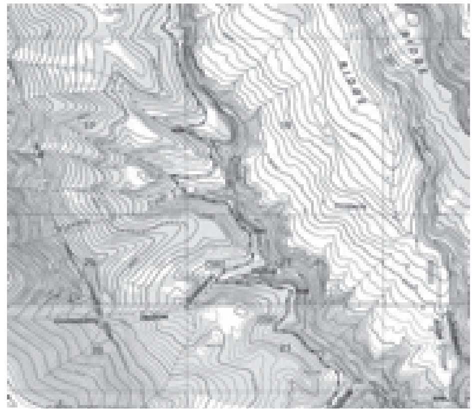
c. Saddle – A saddle is the low ridge between two peaks.



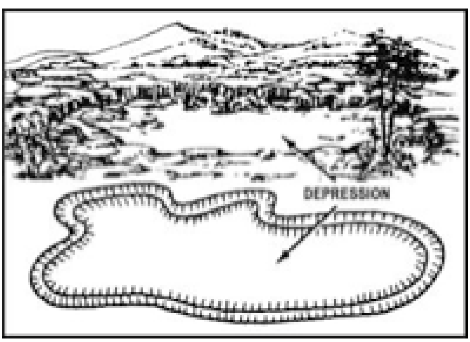


d. Cliff – A cliff is a near vertical slope. The closer the lines are to each other, the steeper the slope. A cliff will be shown on a map by the close contour lines that touch or have tick marks on them. These tick marks will point towards the lower ground.





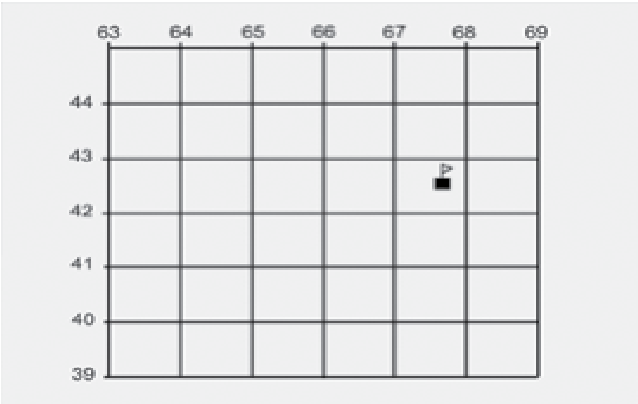
e. Valley – A valley is level ground bordered on the sides by higher ground. Contour lines indicating a valley are somewhat U-shaped.



f. Depression – A depression is a low point or hole in the ground surrounded on all sides by higher ground.

E.O. 1 Measure a Grid Bearing

1. Four-Figure Grid References. When you identify a location using the grid system it is called using a “grid reference.” For centuries, mathematicians have always stated the X coordinate (vertical) before the Y coordinate (horizontal), so map users have adopted that procedure. N-S grid lines are stated before W-E grid lines. Listing the numbers of the grid lines that intersect at its bottom left corner identifies every 1-kilometer (km) grid square.

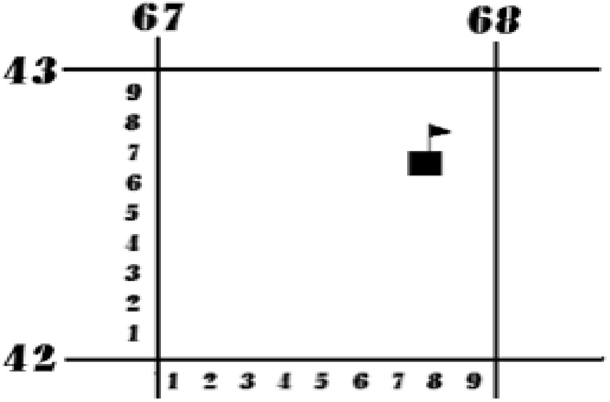


For example: The school is located in the grid square identified as 6742.

Figure 4-3

Remember: a four-figure grid reference refers to the entire grid square. The easiest way to remember to list the N-S grid lines, then W-E grid lines is the saying , “Read right and up.”

2. Six-Figure Grid References. We often need to be more accurate than a 1 km square. Each small easting and northing is numbered 1 to 9, from west to east and from south to north respectively. Then each smaller (100m x 100m) square can be identified listing all N-S grid line, then W-E grid line.



For example: Grid reference 678427 is given, the easting is 678 or 67 and 8/10, and the northing is 427 or 42 and 7/10.

Figure 4-4

Remember: that a six figure grid reference descries a square 100m x 100m—in other words, it is accurate to about 100m.

Review

<u>Orient a Map by Inspection.</u>

Step 1	Identify your approximate location on the map.
Step 2	Identify 2 or 3 prominent landmarks on the ground and find them on the map. Try to use landmarks in different directions.
Step 3	Rotate your map until all identified objects on the map line up with the direction in which objects are located on the ground. If you are near a straight stretch of road, orient your map by using the road. Line up the road on the map parallel with the road on the ground.
Step 4	Check all around you to verify that the features to your front are in front of your position on the map, and so on. The top of your map now points north.

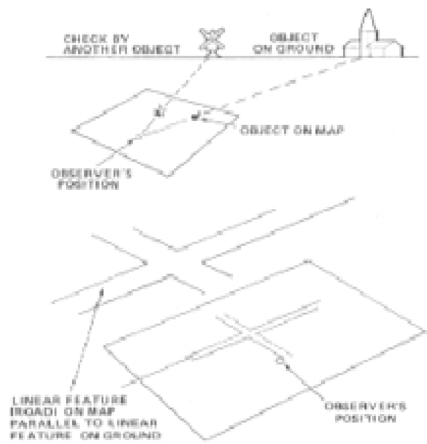


Figure 4-5

1. <u>Measuring Distance on a Topographical Map.</u> There are two ways to describe the distance between features; point-to-point, or along a route. Point to point measures the straight line between points. Measuring along a route might be an obvious path, road, or along your planned route.

a. To measure a straight line between two points:

1) Take a piece of paper and place the upper edge on the map so that it touches the two points.

2) Mark the points on your paper.

3) Clearly indicate your start and finish point.

4) Now place the paper on your scale bars.

5) Calculate the distance.

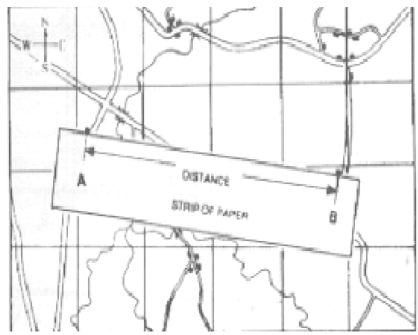


Figure 4-5

b. To measure along a route (road, trail, stream, etc.) between two points:

1) Lay a piece of paper along the first section and mark the paper.

2) Now pivot the paper until it lays along the second section, mark your piece of paper at the end of the section.

3) Repeat this process until you have reached point B.

4) Compare the distance marked on the paper to the bar scale and calculate the distance.

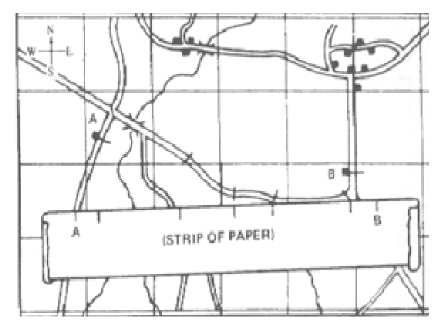


Figure 4-5

2. <u>Contour Lines.</u> The shape of the ground is the most permanent natural feature on your map, and on the ground. While trees get cut down and roads built, etc., the hills, valleys, cliffs and ridges remain pretty much unchanged. Your ability to read contour lines is a great aid to navigation, as well as a major influence on your choice of route.

a. Mapmakers created contour lines as a two-dimensional method of representing three-dimensions. Elevation or 'relief.' On a map is illustrated by joining all points with the same elevation to create contour lines. Now, instead of covering the entire map with contour lines, specific elevation values are selected with intervals between—e.g. every 10m. The value of the difference between the elevations of contour lines is labeled as the 'contour interval' and is printed in the bottom margin of the map. Not all maps have the same contour interval.

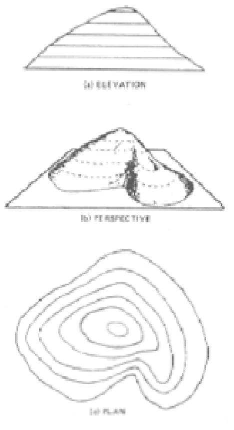
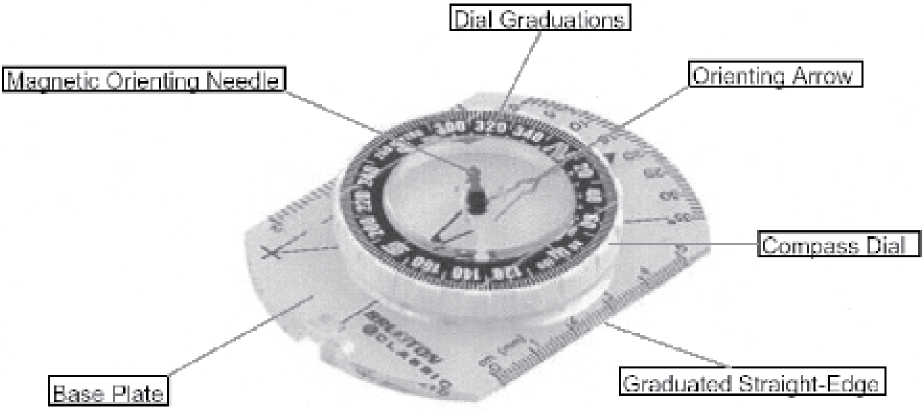


Figure 4-5

b. The contour lines are printed in light brown with every fifth line darker—called "index contour lines." Elevation above Mean Sea Level (M.S.L.) is indicated on some lines, with the numbers (in meters

c. Remember that any change in elevation that is less than the contour interval will not necessarily be shown by contour lines on the map. On a 1:50,000 scale map with a 10m contour interval some hills as tall as a two-story house may not be depicted. In some cases, 'spot elevations' will give you an exact elevation.

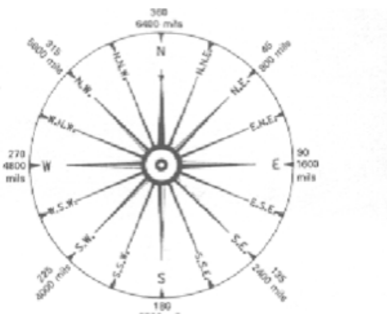
3. Compass. The compass is an important tool used in wilderness navigation. A compass user must take care to be precise in their measurements with the compass. A small error in calculation or measurement can equal a significant error in the field.



a. Most compasses operate on the same basic principle. A small, elongated, permanently magnetized needle is placed on a pivot so that it may rotate freely in the horizontal plane. The Earth's magnetic field which is shaped approximately like the field around a simple bar magnet exerts forces on the compass needle, causing it to rotate until it comes to rest in the same horizontal direction as the magnetic field. Over much of the Earth, this direction is roughly true north, which accounts for the compass's importance for navigation.

b. The Earth has a north and a south magnetic pole. These magnetic poles correspond roughly with the actual geographical magnetic poles. The north magnetic pole is located at approximately 78.9-degrees North latitude and 103.8-degrees W longitude about 1000km from the geological North Pole. The nature of the magnetic field allows the magnetic north pole to shift geographic position about 5 to 10cm per year. Other natural phenomena, like earthquakes, can change the magnetic field locally.

4. Cardinal Points. The four main cardinal points are North (N), East (E), South (S), and West (W). Each of these is divided in half into north-east (N.E.), south-east (S.E.), south-west (S.W.), and north-west (N.W.). The circle is then again subdivided as shown below. Map users would then use these points to describe their direction of travel.



5. <u>The Three Norths.</u>

a. True North (TN)—the earth spins on an axis that passes through the North and South Pole. The geographic North Pole or true North is located at the top of the earth w here the lines of longitude converge.

b. Grid North (GN)—is the north indicated by grid lines on a topographical map. Because N-S Grid Lines are exactly parallel to each other, they will never converge at the North Pole; therefore they are pointing slightly off true north.

c. Magnetic North (MN)—is where a magnetic compass needle points. Magnetic North is shown with an arrow (compass), Grid North with a small square (map grid), and True North with a star (Polaris—the North Star).

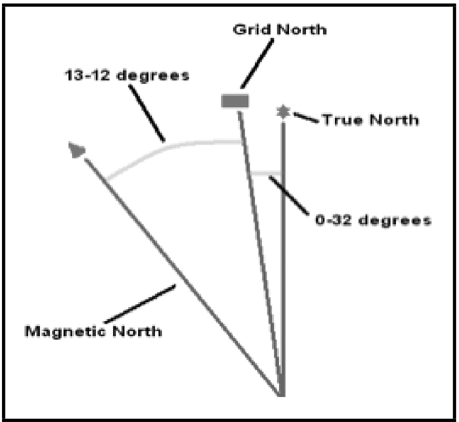


Figure 4-5

6. <u>Mils and degrees.</u>

a. The degree system of bearings shares some structure and terminology with units of time. There are 360 degrees in a circle. There are 60 minutes (60') in a degree, and there are 60 seconds (60") in a minute, and to use decimals of minutes instead of seconds (e.g. 1.5' instead of 1" 30").

b. Mil is a metric-like system for dividing a circle. A circle is divided into milli-radian and there are 6318 mil-radians in a circle. But 6318 is not a convenient number for simple math, so map users commonly use 6400 mils in a circle. At one km each mil is about one meter wide.

c. In the Young Marines, we use only degrees.

7. <u>Orient your Map by Compass.</u> To orient your map with a compass:

a. Rotate the compass dial until N is lined up with the direction arrow on the front of the baseplate.

b. Place the straight edge of the compass alongside any true north line on the map – the left or right border or any line of longitude.

c. Holding the map and compass together at your front, turn your self until the magnetic orienting needle is directly over the orienting arrow inside the dial ("put the red in bed.") Your map is now oriented.

E.O. 2 Measure a Magnetic Bearing.

1. When using a compass there are factors that can cause it to become less accurate:

   a. Compass error—each compass may have an inherent error from manufacturing. You would notice this when comparing bearings taken with one compass, with bearings taken by others. Most new and well taken care of compasses have no measurable error;

   b. Compass deviation—there may be either local geological abnormalities (e.g. large amount of iron content in rock), or other factors like using a compass too close to power lines, wire fence, or vehicles that will cause the magnetic needle to deviate from an accurate reading. You can lessen this chance by moving away from obvious sources of magnetic disturbance or large iron/steel objects—i.e. you will not get an accurate bearing from inside a car!

   c. Damage—air can infiltrate the liquid inside the compass dial (a result of extreme temperatures or damage) forming bubbles that will effect the movement of the magnetic needle, sometimes causing error;

   d. Not holding the compass horizontally causes the needle to try to pivot at an angle, which will cause the needle to move less smoothly and possibly create an error; or,

   e. You are too close to the magnetic north pole.

2. <u>Measuring a Magnetic Bearing.</u> To take a bearing you should:

   a. Select the object on which a bearing is to be taken and face that object;

   b. Hold the compass level in front of your body with the orienting arrow facing the direction you want to go.

   c. Rotate the compass dial with your index finger and thumb until the magnetic orienting needle is over the orienting arrow (red in bed). Ensure the orienting arrow has remained on the object; and

   d. Read the bearing on the compass dial (in degrees) that point to the direction arrow on the front of the baseplate. This is your bearing.

3. <u>Calculating the Back Azimuth.</u> To calculate what the bearing is from that object back to you is a simple matter of subtracting 180 degrees from the original azimuth if it is more than 180 degrees, or adding 180 degrees to the original azimuth if it is less than 180 degrees.

4. Set and Follow a Bearing. A bearing is a quick and efficient method of describing a route to take. The bearing, however, is usually not enough information on its own. There must also be a distance or a target object for you to look for. To set and follow a bearing on a compass follow these steps:

a. Select the object on which a bearing is to be taken and face that object;

b. Hold the compass level in front of your body with the orienting arrow facing the object;

c. You are now facing the direction of the object—using map reading skills you may then be able to navigate to the desired location; or

d. Rotate the compass dial with your index finger and thumb until the magnetic orienting needle is over the orienting arrow (red in bed). Ensure the orienting arrow has remained on the object; and;

e. Read the bearing on the compass dial (in degrees) that point to the direction arrow on the front of the baseplate. This is your bearing to the object. You may now walk to that object, and then repeat as required until you have arrived at your desired location.

5. Navigating with a Map and Compass.

a. Map simplification—the amount of detail on a topographical map causes many people to be overwhelmed when the time comes to make navigation decisions. By filtering the map detail down to only the most important features, or by concentrating on distinct sets of features one at a time, a navigator can make navigation a simpler process. The most common simplification is:

1) Locate the dangers—especially in the winter you need to be aware of bodies of water;
2) Locate the primary contour features—you can even highlight or circle them;
3) Look for unique features—landmarks you may be able to use along your route; and
4) Establish borders—linear features that will keep you within a certain area while you navigate, including your catching feature (knowing these features exist will give you more confidence as you navigate).

b. Route selection—can be strategized by considering the following:

1) What are the features of your target (in orienteering it's called a 'control')? By reviewing all the features of your target in your head, you are more likely to recognize it when you get there;

2) If your target is small, or hidden in difficult terrain, plan your route first to a nearby large landmark that is easy to find (attack point), then navigate from that point to

your target;

3) Plan your route keeping in mind:

   a. Are the skills required to complete the navigation within your ability?

   b. What are the consequences of making an error in each component of the route?

   c. What is the distance traveled—both vertical and horizontal?

   d. How much time should it take for each component?

   e. Working from the target point backwards to the start point can solve difficult route choices.

      i. At what speed or 'tempo' should I attempt to navigate each component of my route? When permitted by terrain, move quickly from the start to your attack point, and then slow down as you approach your target to allow for more precise navigating. Also take note of length and difficulty of the planned route so that you can pace yourself; and,

      ii. What will stop me if I miss? Always choose a catching feature on the far side of your target and keep watch for it when navigating. Avoid approaching a target from a direction where there is a poor or no catching feature.

Note: Route planning is aided by remembering the word CARTS—Control, Attack point, Route, Tempo, and Stop.

a. Aiming off—is a useful compass technique. No one can follow a bearing in a perfectly straight line. When you are planning a route to take you to a distinct location on a linear feature (on a road, creek, contour feature, etc.) you should always 'aim off' to one side. That way, when you arrive at the feature, you will know for certain which way you need to turn to arrive at your destination. If you do not aim off, you may have few clues as to your location when you arrived at the linear feature.

b. Confidence—As you navigate, your level of confidence will fluctuate with success or challenge. When your confidence drops, so will your effectiveness as a navigator. Stay attuned to the 'alarm bells' that go off in your head when your confidence starts to drop. When you first notice that you doubt your location, your map or compass, or the person who gave you the original directions or instructions—take the time to go through the steps of orienting your map, finding your location and reasserting your confidence. Letting the situation worsen will create wasted effort, poor decision-making and/or danger.

E.O. 3 Navigating at Night.

1. Navigating at Night. When traveling at night it may be desirable to enlist the aid of a team member to act as a pointer—instead of choosing a landmark to navigate to. The person on the point moves ahead and acts as the landmark directed by the navigator to move right or left to keep them in line with the bearing. When placed, march to them and repeat the procedure. Remember that at night, distance traveled will feel greater than it actually is.

   a. The “North Star” or “Polaris” has long been used for navigation at night in the Northern Hemisphere. It does not change positions in the sky, resting on a bearing close to True North.

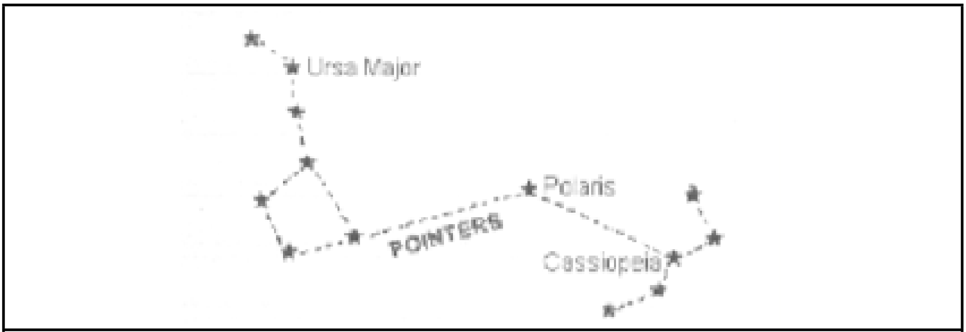


Figure 4-1

   b. Polaris is centered between Ursa Major (“The Big Dipper”) and Cassiopeia, and is the brightest star between these two constellations. Remember—all other stars move in the sky (as much as 300 mils in an hour), you can use them as navigation landmarks for short periods of time only (15 minutes).

PERFORMANCE QUALIFICATION REVIEW
Performance Objective 4: Map and Compass

E.O. No.	Enabling Objective Description and Performance Requirement	Authorized Evaluators Signature
1	**Measure a grid bearing.**	
a.	Plot a grid bearing using a protractor	
b.	Plot a grid bearing using a compass as a protractor	
2	**Measure a Magnetic Bearing.**	
a.	Can successfully measure the magnetic bearing	
b.	Can successfully follow a magnetic bearing.	
3	**Navigating at Night.**	
a.	Can successfully locate the North Star. (Polaris)	
b.	Can successfully locate the “Big Dipper”	
c.	Can successfully follow a magnetic bearing at night with the use of a pointer. (team member as point)	