Red Star Navigation

Bearings:

The main focus in Red Star Navigation is how to use a compass and in particular compass bearings. It is important for cadets to describe bearings as this will assist them in finding the direction of identifiable landmarks on a map. Cadets will rely on this skill set throughout navigation and expedition training. There are three ways we describe direction. All three can be used in bearings.

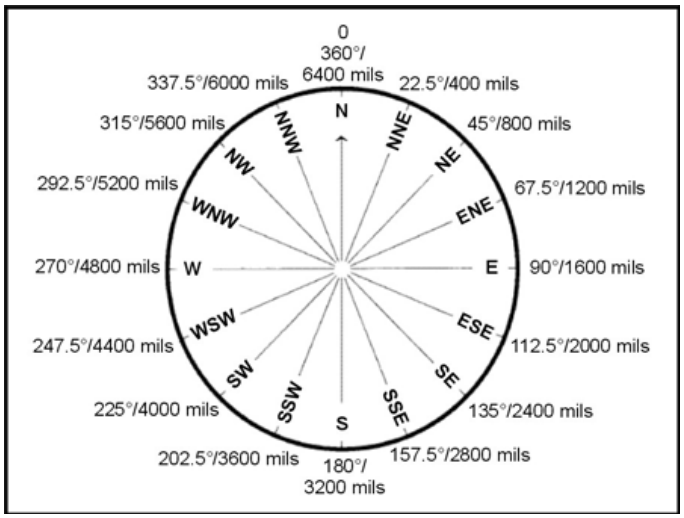
1. **The Compass Rose**

    a. The four **cardinal points** of the compass, measured at right angles clockwise are north, east, south and west. They can be easily remembered by the using mnemonics, such as “Never Eat Shredded Wheat”.
    b. The four **inter-cardinal points** are located halfway between each of the cardinal points. Measured clockwise, they are north-east, south-east, south-west, and north-west.
    c. The eight **intermediate points** are located halfway between each cardinal point and inter-cardinal point. Measured clockwise, they are
        i. north-north-east;
        ii. east-north-east;
        iii. east-south-east;
        iv. south-south-east;
        v. south-south-west;
        vi. west-south-west;
        vii. west-north-west; and
        viii. north-north-west.

Scales on a Compass

To express direction in an accurate and precise method, the full circle of the compass rose is divided into equal measures of angle. This measurement starts and ends at north (top) and always moves in a clockwise rotation. There are two main scales used to measure a circle – they are degrees and mils.

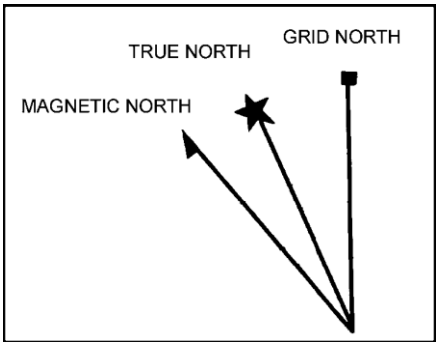
2. **Degrees.** The most common method of dividing a circle is by degrees. There are 360 equal angles in a complete circle and they are represented by the degree symbol (e.g. 360°). On the compass rose, north is located at 0 and 360 degrees, east is located at 90 degrees, south is located at 180 degrees and west is located at 270 degrees.



3. **Mils.** When a more accurate division of the same circle is required, the metric milli-radian (mils) method is used. The mils method has a military background and is based on the metric system with 6400 equal angles in a complete circle. On the compass rose, north is located at 0 and 6400 mils, east is located at 1600 mils, south is located at 3200 mils and west is located at 4800 mils. There are 22.5 degrees or 400 mils between each point on a compass rose.

Types of North

In navigation there are three different norths that are used – true north, grid north and magnetic north. Each north varies a small amount from each other and must be known for use in navigation. A diagram representing the three norths can be found in the margin of any topographical map.



True north is located at the top of the earth where the geographic North Pole is found, and is where all lines of longitude meet. In the diagram on the map, true north is represented by a star (Polaris).
Grid north is the north indicated by the grid lines (eastings) on a topographical map. The easting lines run parallel to each other and will never meet at the North Pole; because of this, grid north points off slightly from true north. In the diagram on the map, grid north is represented by a square (map grid).
Magnetic North is the direction in which the compass needle points. This direction is to the magnetic pole which is located in the Canadian arctic and is slightly different from true north (North Pole). In the diagram on the map, magnetic north is represented by a compass needle.

Types of Bearings

A bearing is an angle that is measured clockwise, from a fixed zero line; north is always this zero line. Simply, a bearing is just another name for an angle.

A **grid bearing** is a bearing that is measure between two points on a map. The ability to measure a bearing from a map allows a map user to plan routes or activities before going into the field, and allows an easy method of communicating information about movement or location.

A **magnetic bearing** is a bearing that is measured between two points using a compass. A magnetic bearing is a quick and efficient method of describing a route to take. The bearing alone is usually not enough information to navigate with and must also have distance or a target object.

A **back bearing** is a bearing that is in the exact opposite direction of the bearing that has been measured. A back bearing can be useful for different reasons; to return to the start location after a hike, or to calculate the bearing from an object to one's current location. Depending on the compass being used, the steps to calculate a back bearing are:

- If the bearing is less than 3200 mils or 180 degrees, add 3200 mils or 180 degrees.
- If the bearing is greater than 3200 mils or 180 degrees, subtract 3200 mils or 180 degrees.

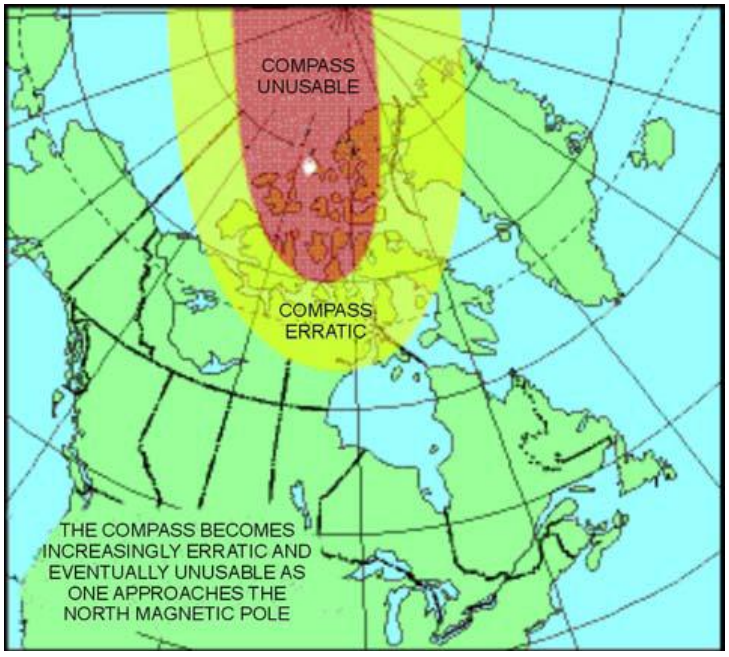
The Compass:

The compass is an important tool used in wilderness navigation. It is not a replacement for good map techniques, but it is a trustworthy tool to compliment and complete navigation skills. 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 magnetic compass is still viable as a navigation aid, even with the advent of Global Positioning System devices, because it requires no batteries, and remains reliable year after year.

CHINESE FLOATING COMPASS

The Chinese discovered the orientating effect of magnetite, or lodestone as early as the 4th century BC. In 101 BC, Chinese ships reached the east coast of India for the first time, possibly with help from a magnetic compass. By the 10th century, they had developed a floating compass for use at sea. Western Europeans had developed one by 1187, Arabs by 1220, and Scandinavians by 1300. Columbus used a magnetic compass on his first trans- Atlantic trip in 1492.

Regardless of their intended purpose or the complexity of their construction, 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. The Earth has a north and a south magnetic pole. These magnetic poles correspond roughly with the actual geographical poles. The north magnetic pole is located at approximately 78.9°N latitude and 103.8°W, about 1000 km from the geological north pole. The horizontal force of the magnetic field, responsible for the direction in which a compass needle is oriented, decreases in strength as one approaches the north magnetic pole – the compass starts to behave erratically, and eventually, as the horizontal force decreases even more, the compass becomes unusable.



The nature of the magnetic field allows the magnetic north pole to shift geographic position about 5-10 cm per year. Other natural phenomena, like earthquakes, can change the magnetic field locally.

Parts of the Compass

A – Sight. Located at the top of the compass cover, the sight is used to align an objective or bearing.

B – Compass Cover. The compass cover protects the compass dial and houses the sighting mirror.

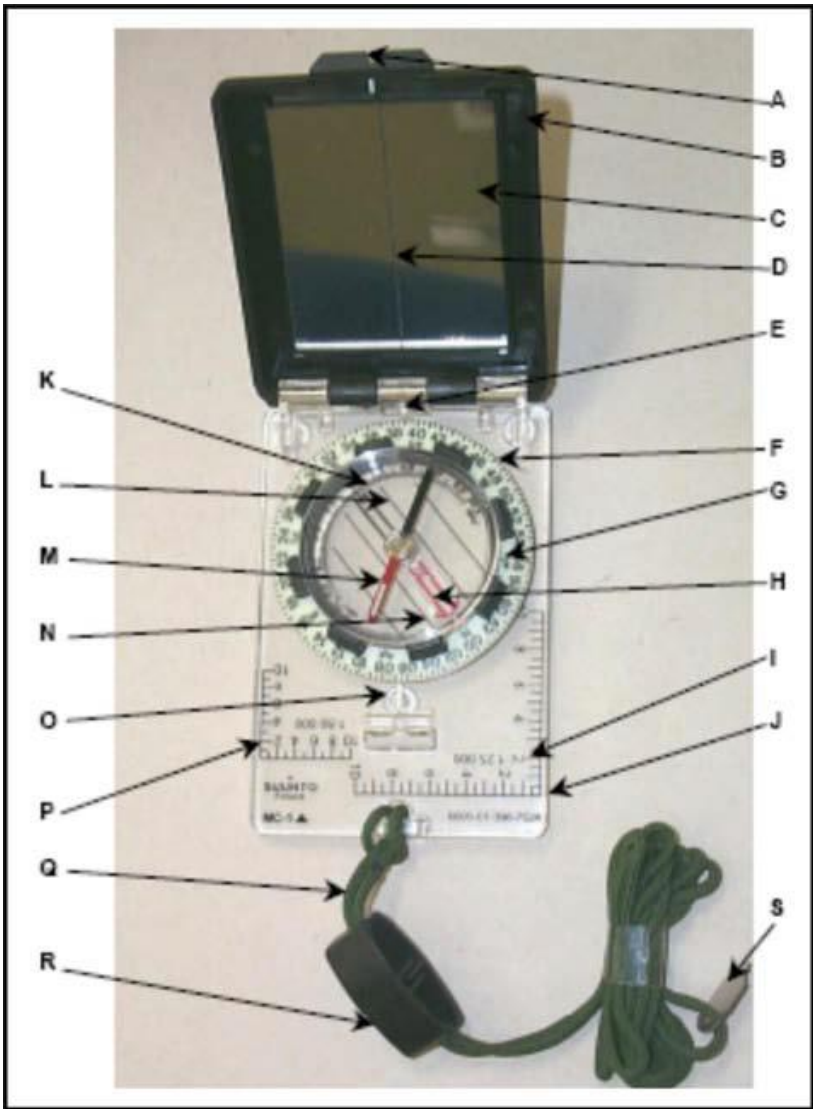
C – Sighting Mirror. The sighting mirror is used to see the compass dial while setting a bearing.

D – Sighting Line. The sighting line is used when aligning the objective or bearing.

E – Luminous Index Point. The luminous index point at the top of the compass dial is where a bearing is set and read from.

F – Compass Dial. The compass dial houses the magnetic needle, the orienting arrow and the declination scale on the inside and the dial graduations on the outside.

G – Dial Graduations. The compass dial is graduated in 50 mil divisions from 0 to 6400 mils, or 2 degree divisions from 0 to 360 degrees. The dial is rotated by hand.



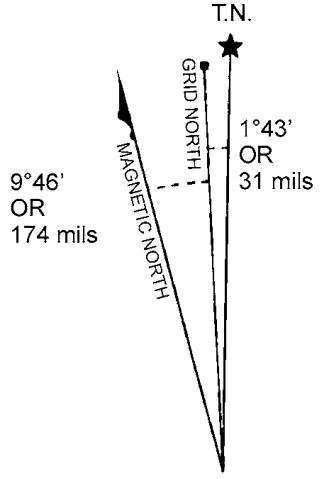
H – Orienting Arrow. The red orienting arrow is located inside the compass dial and is used to line up the magnetic needle. The orienting arrow is always set at 00 mils/degrees.

I – Romer 1:25 000. This romer is used to measure GR on maps with a 1:25 000 scale.

J – Compass Base Plate. The compass base plate is a clear piece of flat plastic, to which the cover, dial and lanyard are attached.
K – Declination Scale. The declination scale is used to compensate for the variation of magnetic declination between the compass and the map being used.
L – Compass Meridian Lines. Compass meridian lines are black or red lines inside the compass dial and are used to line up the compass dial with the grid lines on a map.
M – Magnetic Needle. The magnetic needle spins freely and points to magnetic north. The south end of the compass needle is black and the north end, with a luminous patch, is red. When the magnetic needle is lined up with the red orienting arrows, the mnemonic “Red in the Bed” is used to remember which end of the needle belongs between the arrows.
N – Luminous Orienting Points. There are two luminous orienting points located on either side of the orienting arrow.
O – Luminous Index Point. The luminous orienting point at the bottom of the compass dial is where a back bearing is read from.
P – Romer 1:50 000. This romer is used to measure GR on maps with a 1:50 000 scale.
Q – Safety Cord or Lanyard. The safety cord is used to fasten the compass to the body.
R – Adjustable Wrist Lock. The adjustable wrist lock is used to attach the compass to the wrist.
S – Screwdriver. The tiny screwdriver at the end of the safety cord is used to turn the screw to adjust the declination scale.
T – Declination Adjustment Screw. The declination adjustment screw is located on the back side of the compass dial and is used to adjust the declination scale (not shown).
When exposed to direct light, all luminous parts of the compass will glow in the dark making operating the compass at night possible.

Declination:

Also called magnetic declination, it is the difference in angle measured in degrees and minutes between true north (map) and magnetic north (compass). Declination will change depending on geographic position and it also changes annually due to the shifting magnetic pole. Declination is further described by stating whether the declination is east or west of true north. The declination for the map being used is calculated using the information in the declination diagram found in the margin of the map.



USE DIAGRAM ONLY TO OBTAIN NUMERICAL VALUES
APPROXIMATE MEAN DECLINATION 1982
FOR CENTRE OF MAP
ANNUAL CHANGE (INCREASING) 4.4’

Setting Declination

The compass's declination scale must be set to compensate for the difference between true north and magnetic north. To do this we must first have the amount of declination in degrees east or west. Then, turn the compass over and look at the back of the dial. From the zero point, using the screwdriver on the end of the safety cord, turn the declination screw to the right for west and to the left for east declination. Each small black line is two degrees. When setting declination on a compass, it is easier to hold the screwdriver and turn the compass, especially in cold weather. The declination shall never be turned past 90° on the declination scale.

If you were to follow a compass bearing for 1 km without adjusting for declination, for every 1 degree not accounted for, you would be 178 metres to the left or right of the plotted bearing. This is how important declination is.

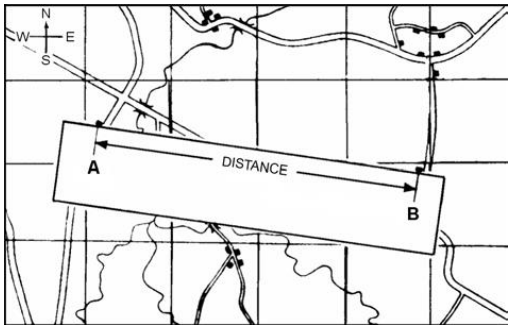
Determine Distance Along a Route:

Cadets can use their maps to measure the distance between two points (A and B) on the ground. All maps are drawn to scale; therefore, a specified distance on a map equals a specified distance on the ground. The scale of a map is printed at the top and bottom of each map (e.g. Scale 1:50 000). This means that one cm on the map equals 50 000 cm (500 m) on the ground. There are two ways to determine distance on a topographical map – point to point and along a route.

Measuring Point to Point

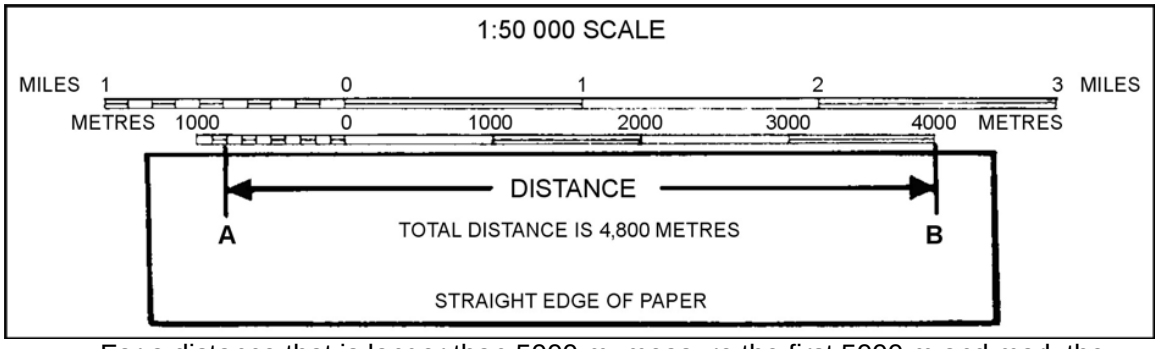
To measure a distance point to point:

1. lay the straight edge of a piece of paper against the two points;
2. with a sharp pencil, mark the paper at the A (start) and B (finish) points;
3. lay the paper just under the scale bar (metres) and move the B mark backwards to each thousands mark until the A mark falls within the sub-divided thousands



(hundreds) to the left of the zero; and

4. to calculate the total distance, add the number of thousands where the B mark is, plus the number of subdivided thousands where the A mark is to the left of the zero.

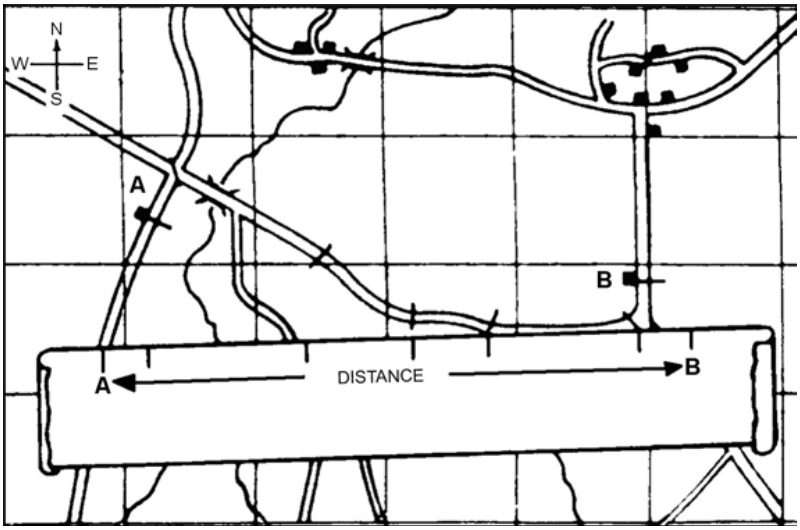


For a distance that is longer than 5000 m, measure the first 5000 m and mark the paper with a new line and label it '5000 m'. Place the new mark at the zero or thousands mark until the A mark fits within the sub-divided thousands bar. Add the total of that distance to the 5000 m and that will be the total distance.

Measuring Along a Route

Sometimes cadets need to find the distance between A and B around curves in a road or along a planned route. To measure a distance along a route between two points:

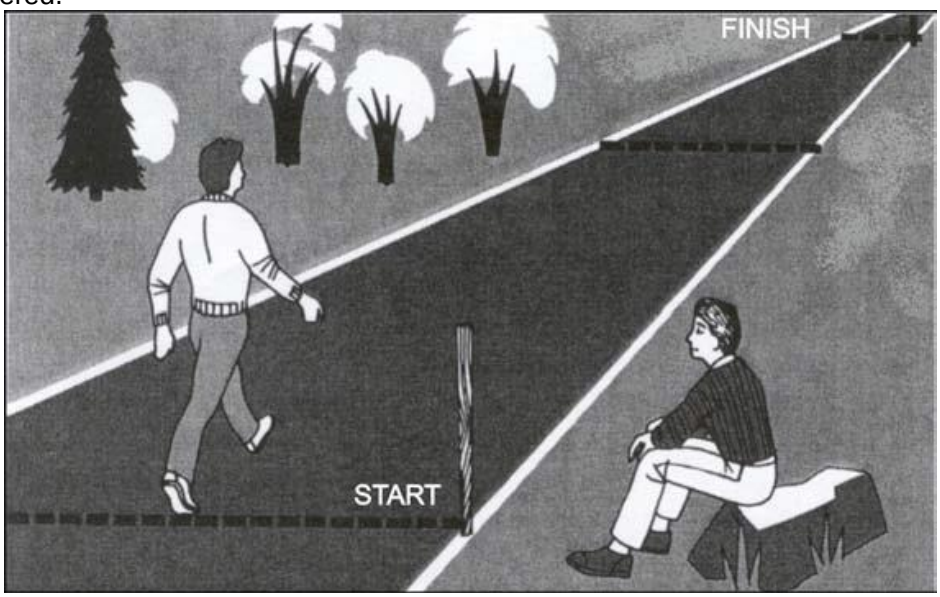
5. lay the straight edge of a piece of paper against point A;
6. with a sharp pencil, mark point A on the paper and the map;
7. line up the paper with the edge of the road until you come to a curve and make another mark on the paper and on the map;
8. pivot the paper so that it continues to follow the road edge. Repeat until you reach point B;
9. mark your paper and the map at point B;
10. lay the paper just under the scale bar (metres) and move the B mark backwards to each thousands mark until the A mark falls within the sub-divided thousands to the left of the zero; and
11. add the number of thousands where the B mark is, plus the number of sub-divided thousands where the A mark is to the left of the zero, will determine the total distance.



Pace Counting

The pace counting method (pacing) is used for measuring a given distance by counting every other step. Two steps equal one pace. Pacing is a very important skill in navigation, as each person has a different pace and needs to establish their pace before it can become a useful measurement tool. Pacing varies between individuals as it uses a natural stride – an average adult will pace about 60 to 70 paces in 100 m.

To determine an individual pace, practice taking uniform, comfortable steps over a measured distance (100 m) counting every second step of the dominant foot. Do this three to five times to get an average. This will be the individual's pace number and should be remembered.



Pacing can be affected by different factors and numbers may vary. Some of the factors and the affect on individual pacing are:

- **Topography.** This is the most common factor. Walking through mud, thick bush and tall vegetation can shorten the paces.
- **Slopes.** Walking uphill will shorten the paces, while walking downhill can lengthen the paces.
- **Fatigue.** Pacing may change from natural in the morning, when cadets are rested, and shorter in the afternoon as they start to get tired.
- **Equipment.** Equipment could affect pacing, such as the wrong type of footwear. Too much or too little clothing and the amount of equipment being carried can shorten the paces.
- **Weather.** Heavy rain, wind velocity, temperature and snow can shorten the paces. Pacing beads can be used to keep track of the distance walked. One bead is moved for every 100 m walked. If pacing beads are not available, stones can be used by moving them from one pocket to another to count every 100 m.

Orient a Map Using a Compass:

It is important for cadets to know how to orient a map using a compass so they can accurately align features found on the map with true north when navigating a long distance. When you are unable to identify details on the map with those on the ground (e.g. you are in a hilly area), or you need to orient the map more accurately when navigating a long distance, a compass must be used.

Set declination set dial to zero align eastings/red in bed.

1. set the current declination on the compass;
2. set the compass dial to read 00 (zero) mils or 0 degrees (north);
3. lay the compass flat on the map with the cover open;
    a. point the mirror to North (top of the map);
    b. align one side of the base plate with an easting line; and
    c. turn the map and compass together until the red end of the magnetic needle is over the orienting arrow. The mnemonic used to remember putting the magnetic needle over the orienting arrow is “Red in the Bed”.

Knowing how to orient a map using a compass is important as it enables you to accurately align the map with true north. It also aids cadets in having a general idea of their location during expedition training.

Following a Bearing from Point to Point:

It is important for cadets to know how to determine the magnetic bearing of a prominent object, take a magnetic bearing on a map and follow a magnetic bearing so they will be able to navigate a route during orienteering and expedition training.

Determining the Magnetic Bearing of a Prominent Object

A compass can be used to identify the cardinal points such as north and south, the direction of travel and the bearing from one’s current location to a prominent object. However, the ability to take a magnetic bearing of a prominent object and to use that information to help identify one’s general location can save hours when trekking. A magnetic

bearing is a quick method for describing the direction of travel. A prominent object is something that is large and easily seen (e.g. church or hilltop).

To determine the magnetic bearing of a prominent object:

1. Check and set the pre-determined declination on the compass.
2. Hold the compass at eye level, at arms length, and face the prominent object.
3. Aim at the object using the compass sight, ensuring the sighting line is in line with the index pointer.
4. Adjust the compass cover so the compass dial is seen in the sighting mirror.
5. Look in the mirror and turn the compass dial until the magnetic needle is over the orienting arrow (red in the bed).
6. Read the number on the compass dial at the luminous index pointer. The magnetic bearing of the prominent object is read at the luminous index pointer.

Taking a Magnetic Bearing on a Map

The ability to measure a bearing from a map allows cadets to plan routes or activities before going into the field, and allows an easy method of communicating information about movement or location. When a compass is adjusted to compensate for declination, it will provide the equivalent of a magnetic bearing. Magnetic bearings may be set on the compass without further conversions. To measure a magnetic bearing on a map:

1. Set the pre-determined declination on the compass.
2. Identify and mark the start (point A) and finish (point B) points on a map.
3. Draw a plotting ray from point A to point B.
4. Lay the fully opened compass with the edge of the compass base plate along the plotting ray, in the direction of travel (point A to point B).
5. Hold the compass in place, rotate the

compass dial so that the compass meridian lines align with the easting lines on the map, ensuring north on the dial indicates north on the map.

6. Read the number on the compass dial at the luminous index pointer. The magnetic bearing is read at the luminous index pointer. If the bearing is taken from point B to point A, the compass will be pointing 180 degrees or 3200 mils in the exact opposite direction of travel wanted. This is also called a back bearing.

Follow a Magnetic Bearing

Using one of the two methods above you have determined your bearing. In order to follow that bearing to your destination use the following steps.

1. Make sure you declination is properly set.
2. Rotate you compass dial so that your bearing is lined up with the index pointer.
3. Hold the compass at eye level and at arm's length. Aim the compass using the compass sight, ensuring the sighting line is in line with the index pointer.
4. Adjust the compass cover so the compass dial is seen in the sighting mirror.
5. Look in the mirror and rotate your whole body until the magnetic needle is over the orienting arrow (red in the bed). This is your direction of travel.
6. Identify a prominent object in your line of travel. Move forward to that object.
7. Repeat steps 3-6 as necessary to reach your destination.