Chapter 6

Map Reading & Navigation

Navigation is a skill which allows you to determine your own position and the location of your destination, on a map or on the ground, and to plan and follow the best route between those two points. The ability to navigate accurately in all weather conditions is fundamental to mountain safety. The leader, in particular, needs to have a thorough understanding of the basics of map reading and navigation, and he should make a concerted effort to gain wide experience in all weather conditions, in all types of terrain.

In theory, navigation is an exact science; the practice is somewhat different. A number of practical considerations, to which the map sometimes provides no guidance, have to be taken into account. These include: the ability of the group, the availability of shelter and water, the type of terrain (which often cannot be judged accurately from the map), and weather conditions. Your planning must therefore be flexible and you must be able to use the map to work out alternative routes.

In order to navigate competently, you should be able to:

- Understand map distance, symbols and scale.
- Know what terrain forms are represented by various contour configurations.
- Supply a grid reference.
- Orient a map visually and by compass.
- Use a map or a map and compass to determine your position.
- Take a true and a magnetic bearing and convert one into the other.
- Calculate a backbearing.
- Walk on a bearing in any weather, navigating around obstacles.

Navigation can be complicated for the climber or hiker by:

- Unfamiliarity with the terrain.
- The short line of sight typical of the mountains.
- Adverse weather conditions.
- The limited number of possible routes.

The more unfamiliar the terrain, the more important it is for the leader of the party to be thoroughly versed in the use of the two most important navigational aids — the map and the compass.

Maps

A map is a symbolic representation, on aflat surface and according to a specified scale, of the earth or a part of the earth and the natural and artificial features

on it. Different kinds of maps are used for different applications, for example road maps, geological maps, sea and airlane maps, and topographic maps. The maps most commonly used by mountaineers are topographic maps.

Topographic maps

Topographic maps provide an accurate representation of the area covered by the map and are usually drawn to a scale of 1:50 000. They are drawn from aerial photographs and checked by field survey. They are well detailed and use conventional map symbols that are easy to use and understand. Relief is indicated by contour lines.

Scale

The scale of a map is the ratio of the distance between two points on the map and the actual distance between these same two points on the ground. Because scale is so important, it is usually indicated in more than one place and in different ways on a map. The three most common ways of indicating the scale are:

- In words (two centimetres to one kilometre).
- As a representative fraction, or R.F. (e.g. 1:100 000).
- By a scale line.

Most topographic maps in South Africa have a scale of 1:50 000. This means that one unit on the map (e.g. one millimetre) represents fifty thousand of the same unit (i.e. 50 000 millimetres, or 50 metres) on the ground. Two centimetres on the map — the length of the side of a grid square — will therefore represent 100 000 cm, or 1 kilometre, on the ground.

To calculate the straight-line distance between two points

1. Use a ruler or pair of dividers to measure the distance on the map.

2. Compare the map distance with the scale line, or multiply this distance by the representative fraction.

To calculate a distance along a winding path or river

Use a piece of string or a blade of grass to measure the distance, and then compare it with the scale line.

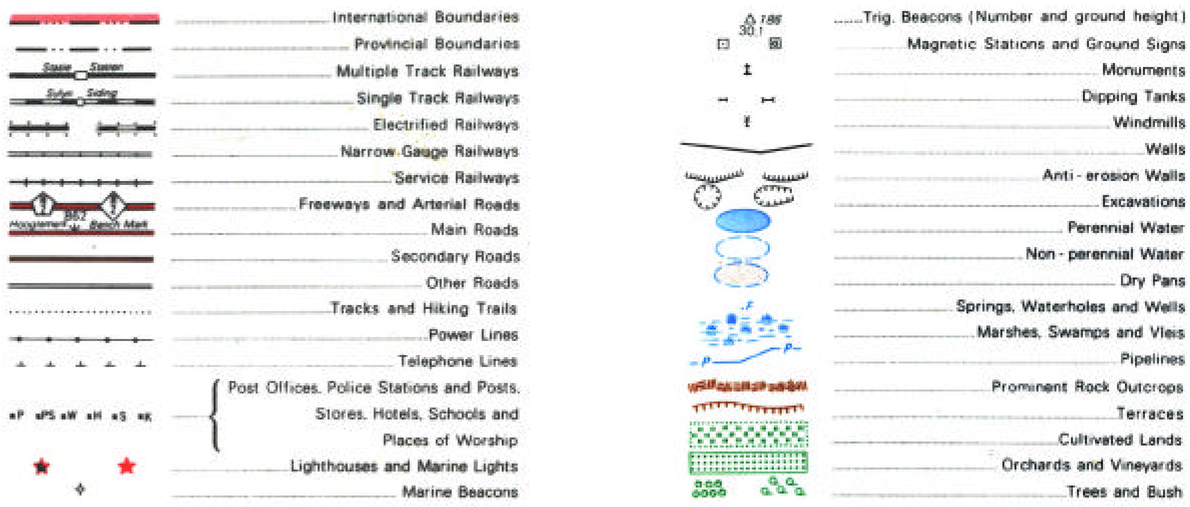
Another way of calculating distance on the map involves the use of a pencil and paper: Divide the distance into a series of straight lines from bend to bend; mark each straight section along the edge of a piece of paper, rotating the paper at the end of each section; and measure the distance obtained by comparing the paper with the scale line. (This method is not very accurate over long distances.)

Conventional map symbols

All topographic maps in South Africa use the same symbols to depict features on the ground. These symbols are also colour-coded to simplify map reading.

- Black symbols are for man-made features such as buildings, power lines, telephone lines, fences, paths, boundaries, etc.
- Red symbols are used to depict certain classes of roads.
- Green symbols are used to indicate agricultural and natural features of vegetation, such as cultivated land, forests, grassland, etc.
- Blue symbols are used to indicate water features.
- Brown is used for contour lines, rocky outcrops and secondary roads.

The key to these symbols is found in the bottom margin of the map.



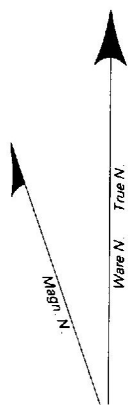
Conventional map symbols

Direction indicator

Topographic maps are usually printed with north at the top of the map. The left and right edges therefore run in a north-south direction, but this is not invariably the case. An arrow indicating true north is always printed somewhere (usually in the left margin) on the map. A second arrow, with the same origin as the first one, indicates magnetic north.

The angle between these two arrows is called the magnetic declination. Maps are usually printed using true (geographic north) as the reference direction, but the compass needle points to the magnetic north pole, which is a point somewhere in Canada, west of true north (for South Africa). Unless magnetic declination is taken into consideration when you use a compass and map together, your bearings will be out by the number of degrees represented by magnetic declination in your area.

Magnetic declination varies from place to place, but in South Africa it varies fairly little (from 14" west of true north at Thabazimbi to 24° west of true north at Saldanha Bay in 1976). The magnetic declination is given both graphically and in writing (with any annual change indicated) in the left margin of South African topographic maps.



Mean magnetic declination 15'.2 West of True North (1970).

Mean annual change 3' Westwards (1966/1970)

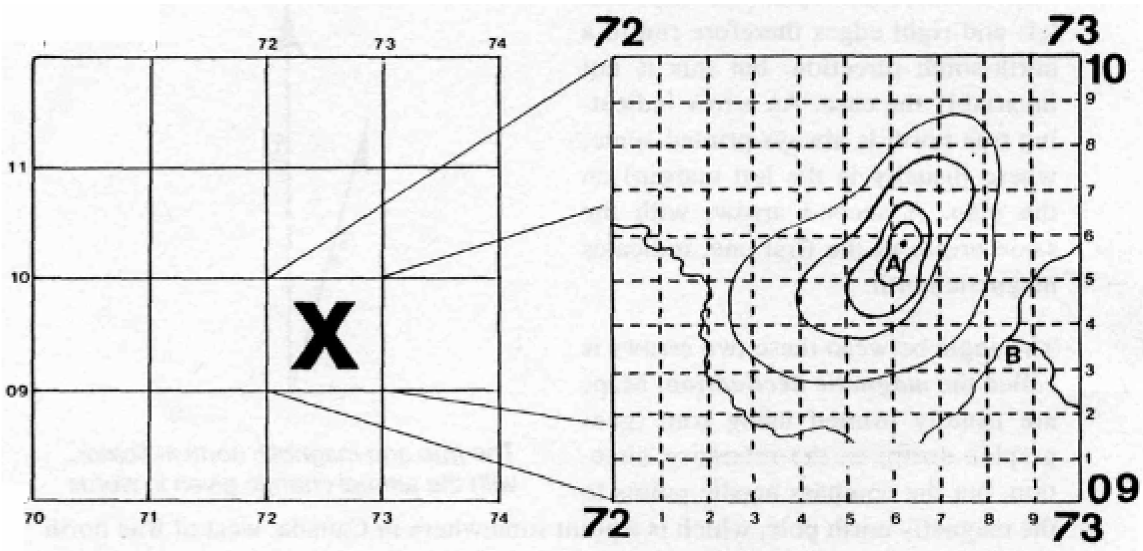
Grids and grid references

The topographic maps generally available in South Africa are not overprinted with a grid. In order to simplify navigation and to increase accuracy it is a good idea to draw your own grid, particularly on maps you use often. If the grid is drawn parallel to true north (i.e. the side of the map), this will enable you to determine bearings from the map, without first having to orient the map.

Should you draw the grid parallel to the magnetic north line on the map, the need to calculate true bearings from magnetic bearings, and vice versa, will be eliminated. A convenient size for the grid squares is 2 cm on a side: the side of such a square will represent 1 km on a 1:50 000 topographic map.

Grid lines on a map, at 1 km intervals. The grid reference for the square is 7209.

An enlargement of square X. The six-figure grid references for A and B are: A: 726 095 (summit) B: 728 093 (river junction)



Four- and six-figure grid references

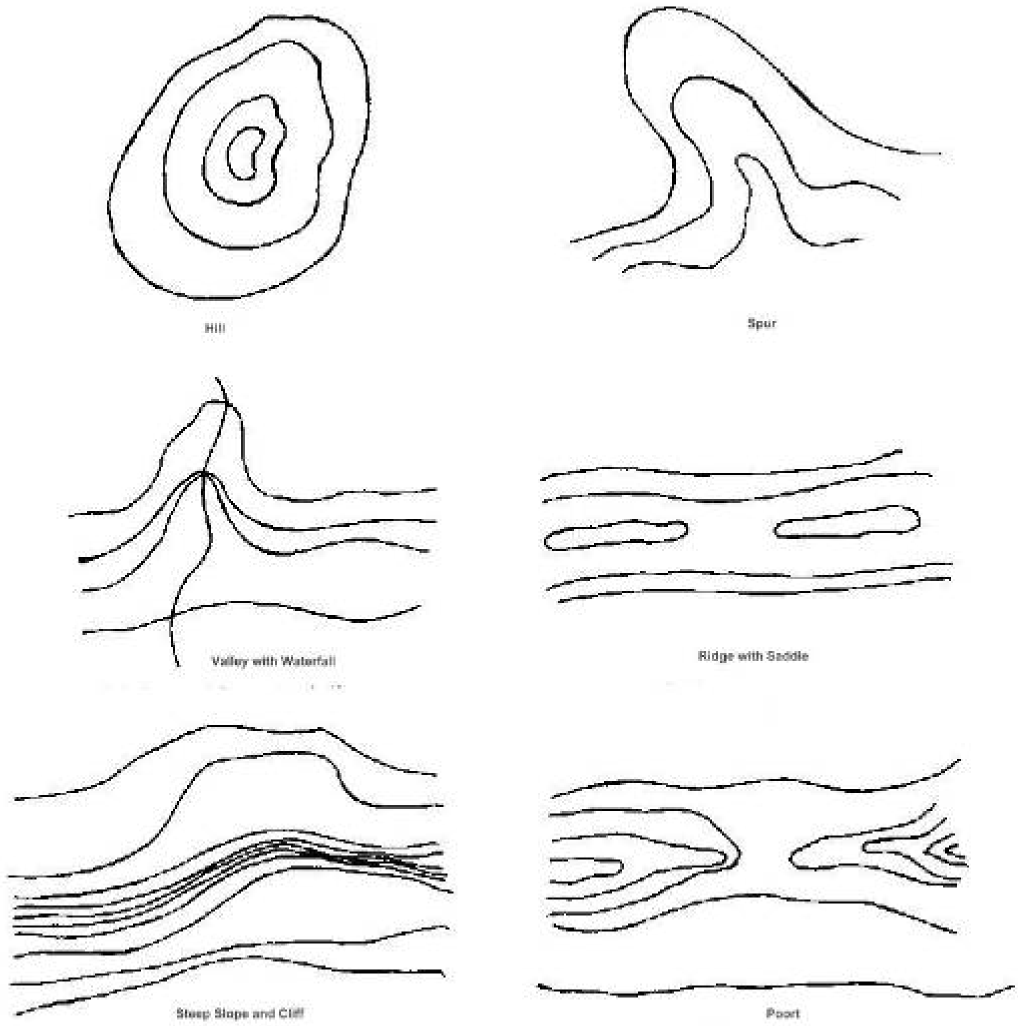
The area covered by a single 1:50 000 topographic map sheet varies with latitude, but it is approximately 27 kilometres by 25 kilometres. On maps supplied with a grid, the grid lines running north/south are called eastings, and those running east/west are called northings. To provide an easy system for referring to any point on the map each line is numbered consecutively in increasing order from left to right for the eastings and from bottom to top for the northings. The numbering starts at 00, increasing by 01 to 99, and continuing with 00 again. A grid reference is a means of referring to a point on the map and usually does not coincide with the latitude and longitude of the map.

To indicate a point on the map (such as your own position) quote the closest easting to the left of the point, followed by the closest northing below the point. This is an international convention and refers to the entire square in the grid which has the quoted easting and northing intersecting at its lower left corner. Such a grid reference is called a four-figure grid reference and represents an area of 1 000 metres by 1 000 metres on a 1:50 000 scale map with a grid drawn at 2 centimetre intervals.

If it is necessary to provide a more accurate reference, a six-figure grid reference can be given by estimating the nearest l/10ths of the grid spacing to the left and below the point for the easting and the northing respectively. The number of l/10ths are then reported as a third digit for the easting and northing. The area represented by a six figure grid reference in the example above will be 100 metres by 100 metres.

Contour lines

A contour line is an imaginary line joining all points of the same height above sea level. A contour line does not have a beginning or an end, but may run off the edge of a map onto an adjoining map.



Contour line representation of various land forms

Contour lines represent the most accurate and the most easily interpreted method of indicating relief on a map. It is very important to know exactly what kinds of land form are represented by various groupings of contour lines; this allows you to choose the least strenuous and safest route between two points.

On any given map the height difference represented by the space between two adjacent contour lines is always the same (e.g. 50 ft., 20 m, etc.), and this difference or interval is called the contour interval. It is usually indicated in the bottom margin of the map.

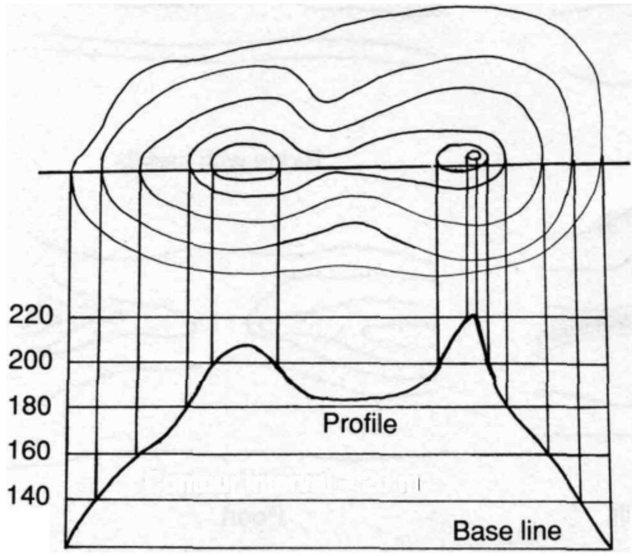
Every fifth contour line is drawn thicker than the intervening contour lines to assist with the interpretation of the features and to make it easier to judge height differences. These thicker contours are usually labelled with the height above sea level in metres (or feet). Because the vertical distance represented by the distance between any two adjacent contour lines never changes, an idea of the relative steepness of a slope can be formed by considering the distance between the contour lines on a map — the closer they are together, the steeper the slope. Where contour lines merge, they indicate a vertical cliff or an overhang.

An experienced map reader will be able to form a fairly accurate idea of land forms by just looking at the map, but when in doubt a profile can be drawn.

To draw the profile of a cross-section of a slope

1. Draw a pencil line across the slope on the map.

2. Place the edge of a sheet of paper along the line.



Drawing the profile of a slope

3. Mark the crossing point of the contours and label them with their height.

4. Draw a base line equal to the length of the section. Choose a vertical scale at a right angle to the base line and mark the heights corresponding to the contours crossing the section.

5. Join the points with a line. (Note: This method exaggerates the vertical relief.)

The altimeter

When used in conjunction with a topographic map, an altimeter, an instrument which is used to determine your height above sea level, can help you navigate accurately, particularly in thick mist in high mountains. If, for example, you are going up or down a well-defined ridge, a compass bearing is unnecessary if you keep to the crest of the ridge. If visibility is poor, however, it can be difficult to tell how far along the ridge you have gone, unless you have an altimeter. While you are traversing round a hill in bad visibility, an altimeter can also help you stay at the correct height and locate crucial points such as a neck or saddle.

Points to note when using an altimeter

- Because it works off barometric pressure, an altimeter is affected by changes in the weather and temperature. It must be continually adjusted by resetting it at known points (do not go for more than ten kilometres horizontal distance or for more than 500 metres vertical height without resetting it).

- The altimeter can be used overnight as a barometer. Either set it to zero or to the height of the overnight spot. If in the morning the instrument shows the height of the spot to be higher than it actually is, the pressure has dropped, indicating the likely onset of bad weather. If it shows the height to be lower, the pressure has risen, indicating that the weather should be fair.

Using the map

Hikers and climbers use maps for three main purposes:

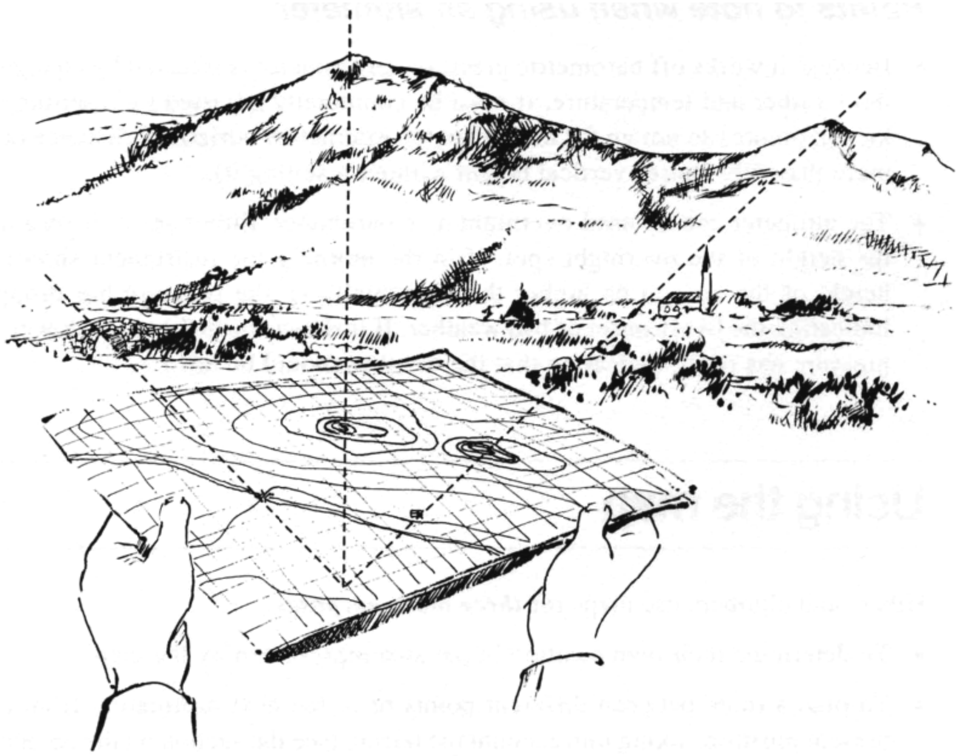
- To determine their own position in the area represented by the map.
- To plan a route between different points or to the next destination from their present position, taking into account the terrain (see the section on the compass).
- To determine distances (as discussed under Scale).

Using a map to determine your own position

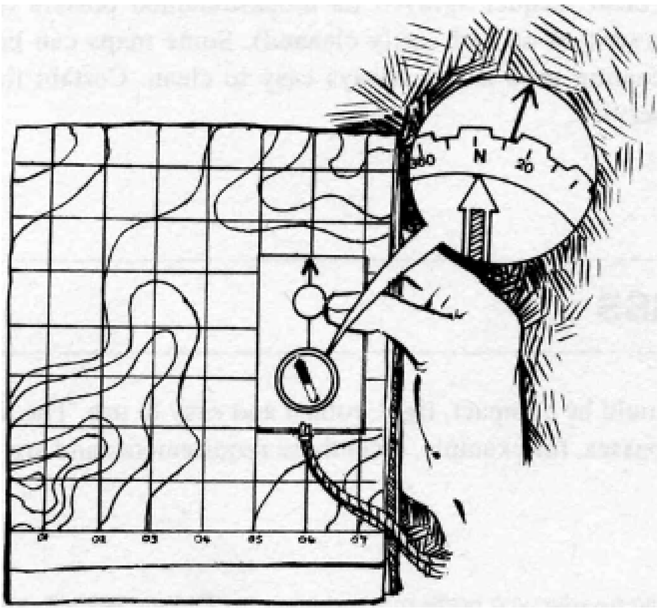
Before you can determine your own position on the ground using a map, you need to orient (or set) the map. This simply means that you need to hold the map in such a way that the true north arrow of the map points to true north (or north on the map points to north in the actual countryside). The features depicted on the map and the same features on the ground will then lie in the same orientation relative to you. A map can be oriented visually or with a compass.

Visual orientation of a map

1. Observe at least two outstanding terrain features, such as two hills, which should have an angle of at least 60° between them (alternatively, the features can lie behind each other in a straight line, relative to you).
2. Locate these terrain features on the map.
3. Turn the map until the map features and the terrain features are aligned in the same direction relative to you — north on the map will now be approximately aligned with true north.



Once the map has been oriented you can determine where you are from the relative position of other terrain features around you. This is not very accurate, particularly if the terrain features are not clearly defined, or if visibility is very poor. However, visual orientation of the map is an essential, basic procedure: Orient the map at regular intervals while walking, thus ensuring that you always know exactly where you are on the map (compass orientation of the map is explained in the next section).



Using a compass to orient the map

Magnetic orientation of a map

1. Lay the map out flat.
2. Set the magnetic bearing of true north on the compass and place it on the map so that the direction of travel arrow is on the true north grid line or a grid line in the map margin (or aligned with it, if you are using a compass with a non-transparent base).
3. Gently rotate the map and compass together until the compass needle coincides with the orienting arrow. North on the map will now be aligned with true north.

Having used a compass to orient the map, you can now visually locate your own position on the map by comparing features on the map with terrain features around you.

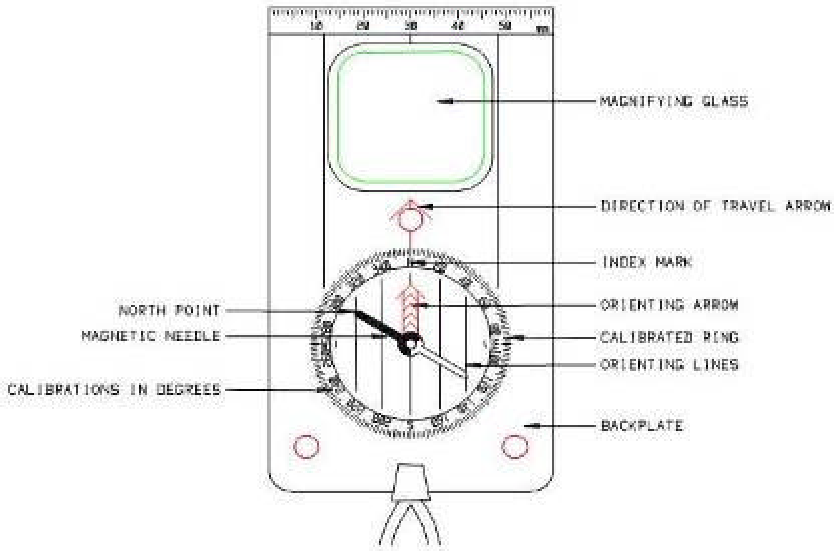
Map care

Maps are subjected to a lot of wear and tear. The ink used on maps is not always waterproof and maps can therefore soon become useless in the rain. Maps tear easily along folds when they have been folded repeatedly. They can also become so dirty that they can no longer be used.

You can protect a map as follows: Cover it with a clear adhesive plastic covering or spray it with the clear lacquer sprayed on block-mounted posters (this also allows the map to be written on and easily cleaned). Some maps can be bought pre-coated, but the coating used is not always easy to clean. Certain firms also offer a map coating service.

The compass

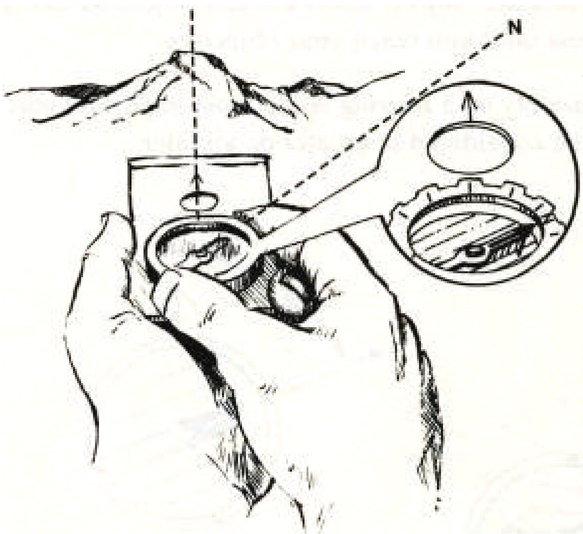
A hiking compass should be compact, light, robust and easy to use. The Silva and Recta ranges of compasses, for example, meet these requirements and are relatively inexpensive.



A typical hiking compass

Bearings

A bearing is the angle between north and a specific point or course measured from a given position. It is always measured in degrees clockwise from true or magnetic north to give a true or magnetic bearing, respectively.



Taking a magnetic bearing to a terrain feature

Magnetic bearings

To take a magnetic bearing to a visible object

1. Face the feature or point of which the bearing is to be determined, holding the compass level in one hand so that the direction-of-travel arrow points directly ahead of you.

2. Point the direction-of-travel arrow at the object.

3. Turn the calibrated ring, or scale of degrees, (while holding the baseplate still and level) until the north end of the compass needle points to north (0°) on the calibrated ring.

4. Read off the magnetic bearing on the calibrated ring at the index mark.

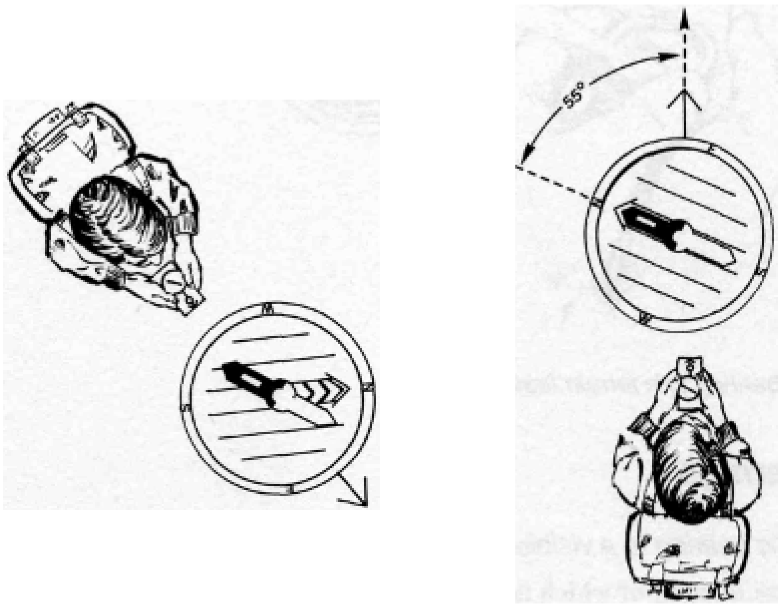
Walking on a bearing

1. The magnetic bearing to an object — such as a hill top — in whose general direction you wish to walk is set on the compass by turning the calibrated ring until the required bearing coincides with the index mark.

2. Holding the compass level, with the direction-of-travel arrow pointing directly in front of you, turn until the compass needle aligns with the orienting lines, with the north end of the needle pointing to 0°. Look down the direction-of-travel arrow and select a distinct feature between you and the hill top, e.g. a single tree or large rock.

3. Once you have reached that object, select another object on the same bearing and repeat the process until you reach your objective.

The ability to walk accurately on a bearing is the most important part of map and compass work and will be considered in greater detail later.



Walking on a bearing

Map (True or Grid) bearings

To measure a grid bearing to a point

1. Draw a thin pencil line on the map from your position to the point.

2. Measure the angle between this line and a north-south grid line (an easting) with a protractor.

Silva and Recta compasses can be used as a protractor — this eliminates the need to carry a separate protractor:

1. Draw a line from your position to the point on the map.
2. Place a long edge of the compass along this line with the direction-of-travel arrow pointing towards the point of which the bearing must be determined.
3. Rotate the calibrated ring (while holding the baseplate firmly) until the orienting lines align with a north-south grid line, pointing north.
4. Read off the bearing on the calibrated ring at the index mark. This is a true north bearing and can be converted to a magnetic bearing by adding the magnetic declination.

If the map has a set of grid lines, it need not be oriented to determine the bearing between the two points. The magnetic needle is then also ignored while using the compass as a protractor.

Magnetic anomalies

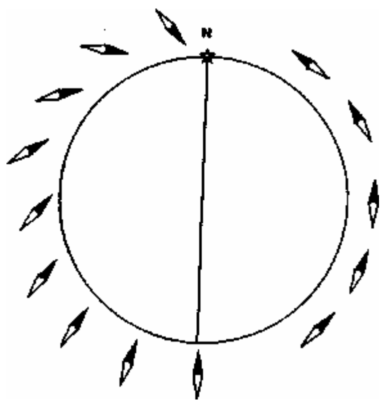
Magnetic declination ('variation')

This is the angle between the bearing from your position to true (geographic) north and the bearing to the magnetic north pole (magnetic north) indicated by the compass needle. (In other words, it is the variation between 'true' and 'magnetic' north.) This magnetic anomaly occurs in the horizontal plane.

Magnetic inclination ('dip')

This little-known anomaly occurs in the vertical plane. It is the angle between the direction of the earth's magnetic field and the horizontal. This phenomenon is used to locate the precise position of the magnetic north pole — an inclinometer will point straight down at the magnetic north pole and will be horizontal at the equator.

Uncorrected 'dip' of a compass needle



Corrected 'dip' of a compass needle

To compensate for magnetic inclination, compass needles are minutely weighted so as to keep them close to the horizontal in the appropriate 'zones of inclination'. A compass weighted for the northern hemisphere will not necessarily function effectively in the southern hemisphere, and vice versa. Incorrect readings can be obtained using a compass weighted for a different zone of inclination, as the needle might not swing freely. Reputable compasses bought locally are appropriately weighted; be careful though of compasses you purchase abroad.

Conversion of bearings

Map to compass

To convert a true (map) bearing to a compass bearing, add the magnetic declination to the true bearing.

Since the compass needle points to a point on the earth's surface some 10° west of true north, you will bypass your objective if you walk on a true (map) bearing without first adding the magnetic declination to it.

Compass to map

To obtain the true (map) bearing, which can be drawn in on the map, subtract the magnetic declination from the compass bearing.

Two useful mnemonics for remembering when to add or subtract the magnetic declination are:

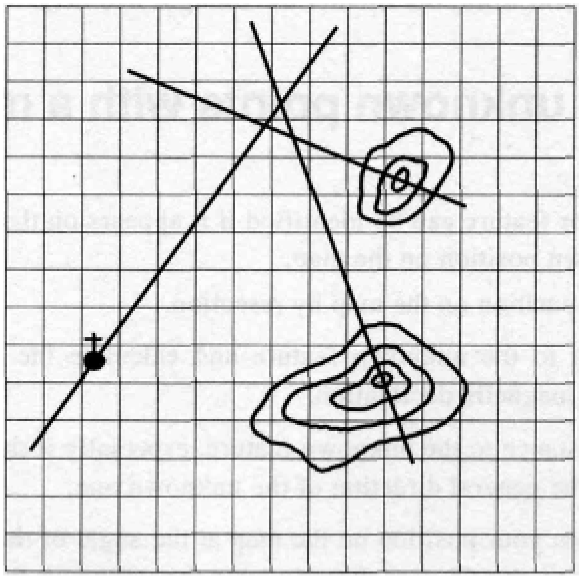
UPMA — Up from the map = add and DOMS — Down to the map = subtract.

Determining your position on a map using a compass

Resection is a method for locating your position on a map with precision by using a compass. It can only be used when at least two terrain features can be observed which can also be identified on the map.

To find your position on the map, using resection

1. Identify two or more landmarks on the ground and on the map.
2. Take magnetic bearings to the landmarks.
3. Subtract the magnetic declination to obtain true bearings.
4. Set the true bearing to a landmark on the compass and pencil in a line on the map on that bearing, with the line passing over the landmark. Repeat this process for each landmark with the calculated bearing.
5. The lines will intersect close to your position.



Determining your own position by resection. Less accurate map and compass work will produce a larger 'cocked hat'.

Let us consider these steps in greater detail:

- The terrain features, or landmarks, should be distinct, some distance apart, and preferably at right-angles to each other.
- At least two landmarks are required, so that you have cross-bearings to fix your position.
- The magnetic bearings must be converted into true bearings by subtracting the magnetic declination.
- Set the true bearing to the first landmark on the compass. Place the compass on the map so that the edge of the base plate intersects the first landmark (provided you have a compass with a rectangular base plate). Keep the edge of the plate on the landmark and, without disturbing the setting, swivel the compass on the map until the orienting lines are parallel to the grid lines (or the sides of the map) and the orienting arrow points to north on the map. Ensure that the edge of the compass base plate still passes over the landmark and then pencil a line on the map along the edge of the compass. Your position is somewhere along this line. Repeat this procedure for the compass bearings to the other landmarks.
- If you take bearings to three landmarks it is unlikely that the lines will intersect in exactly the same place. It is more likely that there will be a triangle of error (also called a 'cocked hat'), with your position somewhere in this triangle. (The more accurately you work, the smaller the triangle will be.)

Identifying unknown points with a map and compass

An unknown peak or feature can be identified if it appears on the map and if you can identify your own position on the map.

1. Find your own position on the map by resection.
2. Take a bearing to the unknown feature and calculate the true bearing by subtracting the magnetic declination.
3. Estimate the distance to the unknown feature, especially if there is more than one feature in the general direction of the unknown one.
4. Draw a line from your position on the map at the angle of the calculated true bearing. This line should pass directly over the unknown feature which can then be identified from the map. (The distance is estimated to ensure that the correct feature is chosen on the map.)

Backbearings

A backbearing is the bearing in the opposite direction to your objective.

To calculate a backbearing

1. Take a map bearing or a bearing to a landmark, using a compass.
2. If the bearing is less than 180°, odd 180°.

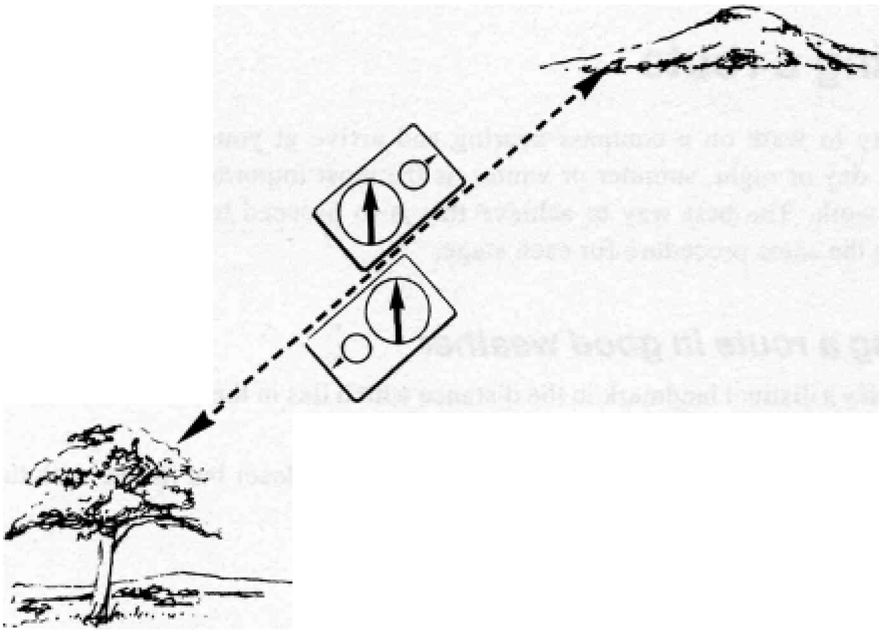
If the bearing is more than 180°, subtract 180°.

Example:

Bearing 60° Backbearing = 240° (60° + 180°)

Bearing 295° Backbearing = 115° (295° - 180°)

(A simple means of checking: there are only 360° in a circle — if the backbearing is greater than 360° you have made a mistake.)



The relationship of a bearing to a backbearing

Situations in which backbearings are useful

- If, in the middle of a flat plain which you are crossing on a given bearing, e.g. 120°, you have no object ahead of you to aim towards, you know that if you keep a visible object or landmark behind you on a constant bearing of 300° you will be walking in the right direction.
- If mist obscures the point ahead of you, while a landmark behind you is still clear.
- If you are lost: you can retrace your route along the backbearing (this is called backtracking).

Backtracking

If you need to locate a particular place (where, for example, you left an injured person to seek help) backtracking is used as follows:

1. Take a bearing to a landmark in the direction in which you will go for help and which you will easily be able to identify again when you return.
2. Pace off the distance to this point, counting one for every pace you take with your left foot.
3. When you return, walk on the backbearing from the distinct landmark originally chosen, checking the number of paces.

Walking a route

The ability to walk on a compass bearing and arrive at your destination in all weathers, day or night, summer or winter, is the most important part of map and compass work. The best way to achieve this is to proceed by 'legs', or stages, following the same procedure for each stage.

Walking a route in good weather

1. Identify a distinct landmark in the distance which lies in the direction you must walk.
2. Look for one or more smaller landmarks somewhat closer but in line with the distant landmark.

Poor navigation can have disastrous consequences!

1. Now you can simply walk from one feature to the next. This permits minimum use of the compass and makes allowance for contouring around ridges and obstacles. You can deviate from the direct route if you need to and return to the original route by realigning the landmarks that you originally identified and using the relative positions of the most distinct features that you pass.

   This method works very well when the visibility is good and you can see distinct landmarks relatively far away. Remember to look for landmarks behind you as well as ahead of you; you can occasionally use backbearings to confirm that you are still heading in the right direction.

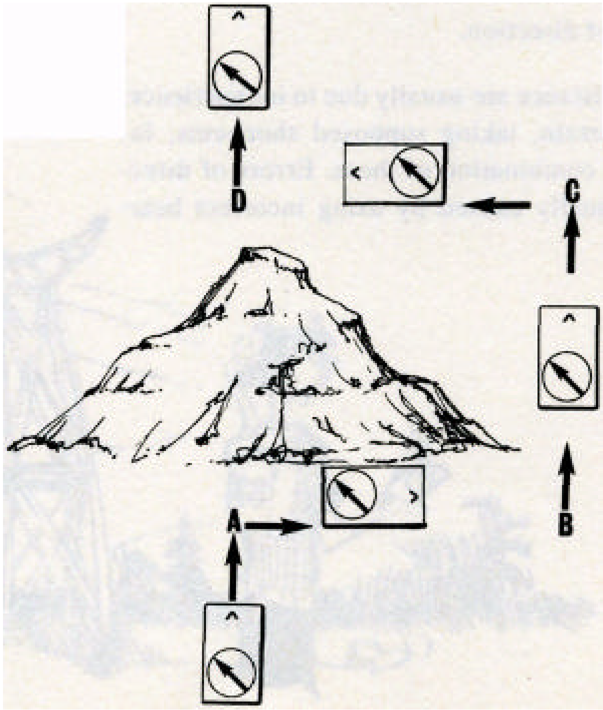
Walking a route in bad weather

1. It is much more difficult to stay on course when visibility is limited.
2. The same method as described above is used, but the landmark chosen will be much closer. If no landmark can be seen, a person can be sent ahead to act as a landmark. He can move left or right until he is standing in the right direction and the group then moves up to him. The process is then repeated. Another way to keep on course is to let the first and last person in the group walk by compass. The last person must check that the person in front (and the rest of the group) is moving in the right direction.

In thick mist it is very important to keep your compass handy, so that you can take a bearing to a landmark if the mist should clear partially even for a few seconds. Remember — if visibility is extremely bad it is better to sit out the bad weather and to move only once visibility has improved sufficiently to allow you to keep moving safely. To blunder on, not knowing whether you are on course or not, is foolhardy and dangerous.

Navigating around obstacles

Occasionally, obstacles such as a rocky outcrop or dense thorny thickets will require you to change course and walk around the obstacle.



Navigating around an obstacle

If you can see a prominent feature

1. If you can see a prominent feature (e.g. a single tall tree) in line with your bearing on the other side of the obstacle, walk around the obstacle towards the feature.

2. Continue walking on your bearing to the landmark. If necessary, double-check by taking a backbearing to the point you came from.

If you cannot see to the other side of the obstacle

1. On reaching the obstacle, change direction by 90° and walk until you are clear of it; count the number of paces you take.

2. Return to your original bearing and walk until you have passed the obstacle.

3. Change direction back again by 90°, and walk the same number of paces back to your original route; continue walking on the original bearing.

Common navigating errors

The two most common types of navigating error are:

- Errors of distance.

- Errors of direction.

Errors of distance are usually due to inexperience, difficult terrain, taking supposed short-cuts, fatigue, or a combination of these. Errors of direction are usually caused by using incorrect bearings.

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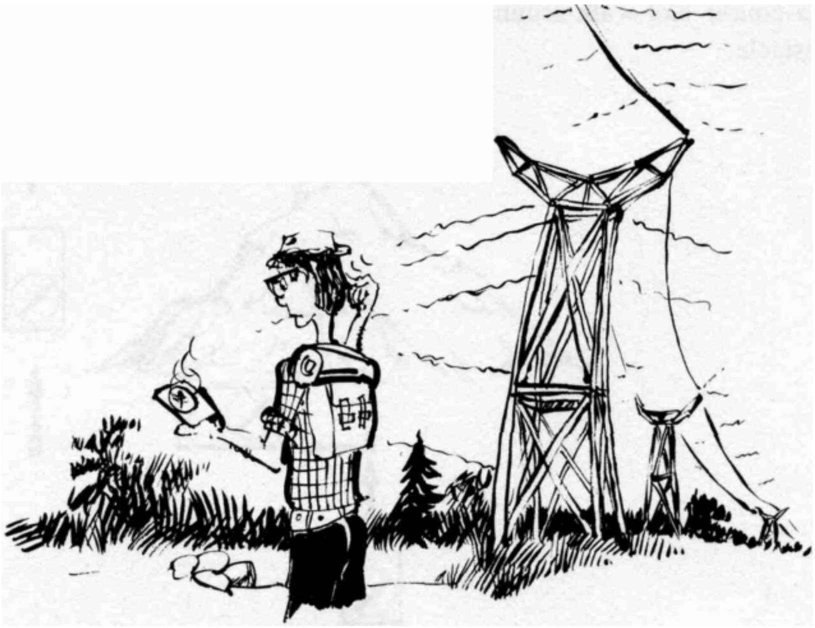


Metal objects such as electricity pylons can play havoc with compass bearings

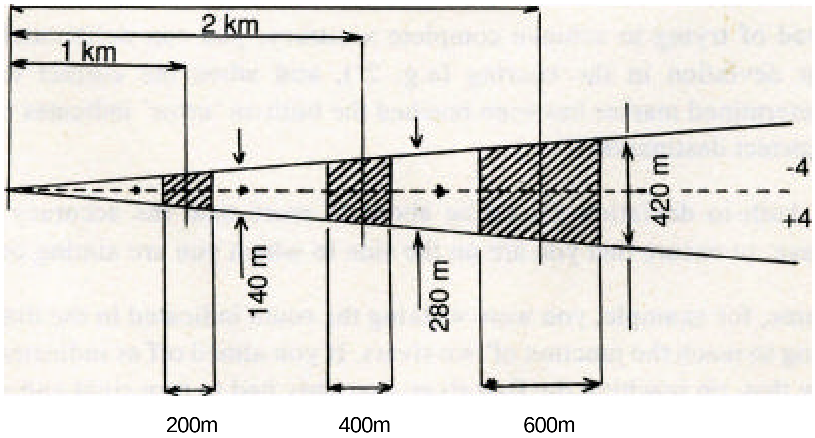
Some *causes of erroneous bearings*

- Interference by the earth's magnetic field, caused by metallic deposits in the ground.
- Metal objects in your pockets, fences, power lines, rucksacks, and even spectacles can effect the direction indicated by the compass.
- Not holding the compass level or holding it upside-down. The compass needle will not be able to move freely to align with the earth's magnetic field.
- Aligning the wrong end of the compass needle with north — this 180° error is often made by beginners.
- Using magnetic bearings instead of true bearings, or vice versa.
- The incorrect calculation of true bearings from magnetic bearings, or vice versa.

An error of 4° over a distance of 1 km will give a possible error of 70 metres (an inexperienced person usually makes an error of this magnitude). An error of 180° results in the hiker going in exactly the opposite direction to the intended direction and therefore gives an error of 2 km after only 1 km has been walked (another mistake commonly made by beginners).

An error of 0,5° over a distance of 1 km will give an error of approximately 9 m (an experienced person with a prismatic compass usually achieves this accuracy.). An error of 20° over 1 km will give an error of approximately 365 m (if magnetic variation is not taken into account an error of approximately this magnitude is made in South Africa).

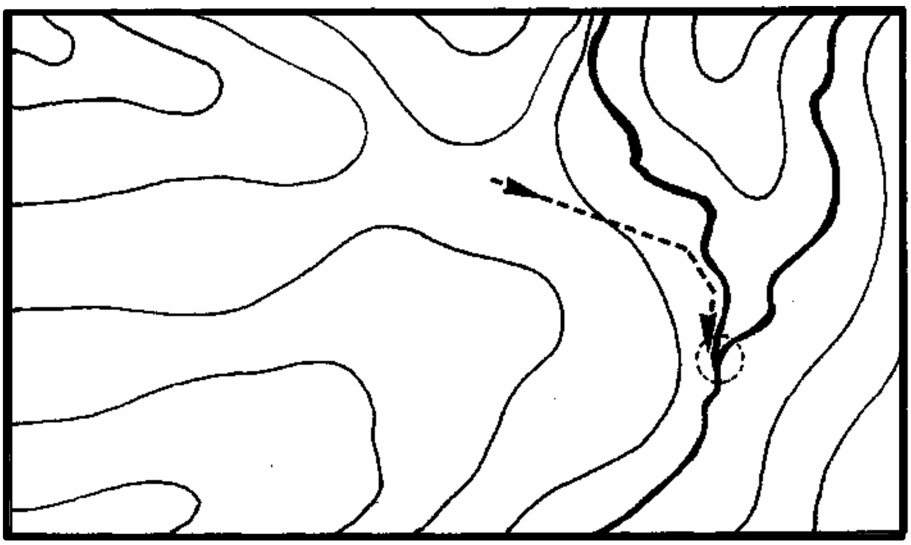
The magnitude of these errors increases with the distance walked. This implies that even experienced hikers can make some impressive blunders if they do not regularly check the accuracy of their navigation.



The effect of errors is compounded by distance

Aiming off

If your line of sight is limited and you arrive at the place where, according to your estimate, the point towards which you were heading should be, you are often unable to tell whether the objective is to your left or to your right. The technique of 'aiming off is based on the principle that it is virtually impossible to achieve complete accuracy when walking on a bearing.



The technique of aiming off. By walking on a bearing which is sure to bring you to the left of the river junction, you are ensuring that you will simply have to turn right once you reach the river.

Instead of trying to achieve complete accuracy, you can deliberately build in a slight deviation in the bearing (e.g. 2°), and when the correct distance or a predetermined marker has been reached the built-in 'error' indicates to which side the correct destination lies.

This built-in deviation should be about 1° more than the accuracy you usually achieve, to ensure that you are on the side to which you are aiming off.

Assume, for example, you were walking the route indicated in the diagram above, aiming to reach the junction of two rivers. If you aimed off as indicated, you would know that, on reaching the first river, you only had to turn right and walk along it in order to reach your destination.

Had you tried to walk on the precise bearing, you might have arrived to the right of the junction and would not have known whether it was to your left or to your right.

Night navigation

Night navigation is difficult, even for experienced hikers, since landmarks usually cannot be observed and bearings therefore cannot be taken. In addition, it is very difficult to estimate distances at night.

Plan a route which can be divided into stages which end at very distinct features, such as a river. Avoid heading towards dangerous points, such as the edge of an escarpment, and keep the stages short.

Prior to a night hike, or even before planning the various stages of a night hike, you should know your exact location on the map. Work out compass bearings and distances for each leg of the hike and write them on the map. Set the first bearing on the compass and proceed, keeping as accurate a pace count as you can. At the end of each stage you should confirm that you have in fact reached the point you were aiming for, before continuing with the next stage.

Common sense navigation

- Above all, you should try to know at all times where you are on the map.
- Trust your compass, not your sense of direction, especially when tired, pressed for time, or in bad weather.
- Try to stay clear of metal objects when using a compass.
- Maps age — check the date of the survey if you suspect that the map does not show all the man-made terrain features.
- Plan your route ahead.
- Observe the terrain around you and form an idea of the relative position of landmarks around you; try to anticipate when certain landmarks will become visible.
- Plan and execute your route in stages, or legs — keep direction by using landmarks in the far distance with a few closer ones in between.
- Use an off-route landmark that can be seen from almost anywhere along the route. This gives a good reference point at any time or place along your route.
- Use the technique of aiming off.
- Remember that you do not always see the true top of a peak when lower than the summit but that trigonometric beacons are excellent reference points.
- Contouring is often (but not always) easier and faster than a direct route.
- It is best to sit out conditions in which visibility is too poor to allow you to take any bearings: 'when in doubt, sit it out'.
- Remember that you need to continue supervising the group even while coping with the problems of navigation.
- Experience, acquired by night and by day, in all weather conditions, is the best teacher.