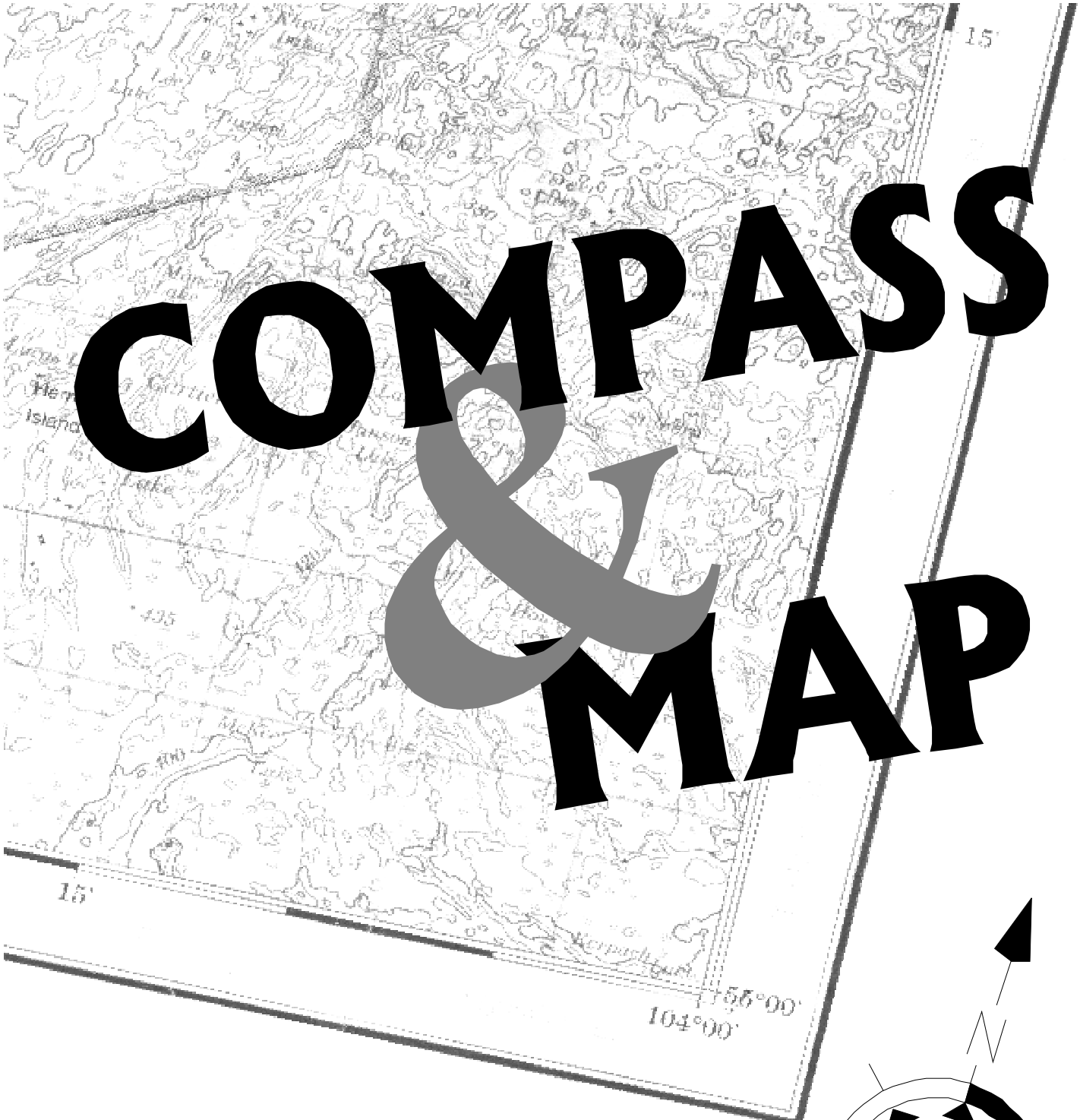
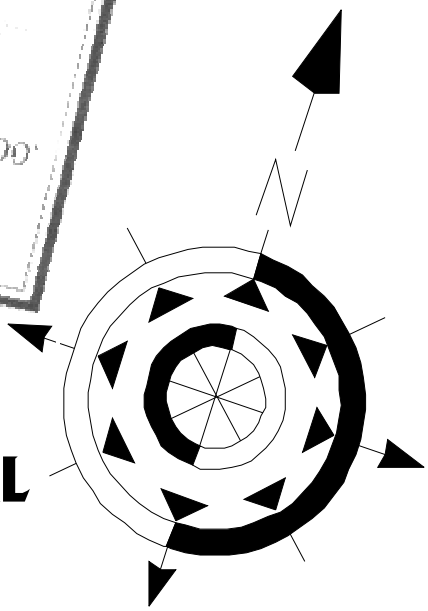


COMPASS & MAP

PRACTICAL TRAINING MANUAL



FOREWARD

This Practical Training Manual was produced as a teaching aid for instructors to teach beginners and as a refresher course for the more seasoned compass user. This manual was written with the Silva Ranger compass or one of similar construction and features in mind. The same principals and rules apply to other compasses and they can be used with only slight adaptations. The cheap toy compass may not have the precision durability or the features as a hundred dollar one, but all it has to do is point to the North Magnetic Pole. After all, isn't that all any compass really does?

Compasses are a precision instrument and people who work and travel in the woods often rely on them to work properly when required. Those who know the value of a compass will try to get the best one they can, and take care of it.

Learn to use a compass, it may not save your life, but it can sure save a lot of walking!

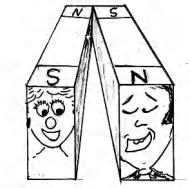
HISTORY of the COMPASS

Over 4,000 years ago it is said that the Chinese knew about the “magical” properties of a natural occurring rock we now know as “lodestone” or “magnetite” The Chinese did not know that it was an iron-containing volcanic rock whose atoms aligned themselves with the Earth’s magnetic field as they cooled, thus becoming magnetized or “magnetic”. They knew that a piece of the magnetic rock strapped to a floating piece of wood or hung by a thread, always pointed in the same direction. By 1200 AD the Arabians and Scandinavian Vikings began using crude compasses for navigation. It was around this time that Marco Polo arrived back from China bringing the first compass to Europe.

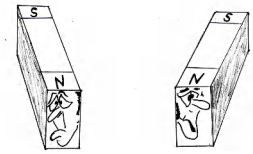
Sailors around the world cherished the magnetic compass because they could now keep a more steady course during cloudy days or nights when the sun and stars were not visible. Although they were crude and often unreliable the magnetic compass eventually proved to be a valuable tool. Very little was known exactly how a compass worked. It was learned that the compass needle could lose its magnetic properties and had to be “stroked” with a piece of “lodestone” to re-magnetize it again. It was much later on, around Christopher Columbus’s time, before things like magnetic variation or the difference between magnetic and true north were discovered.

HISTORY of the COMPASS

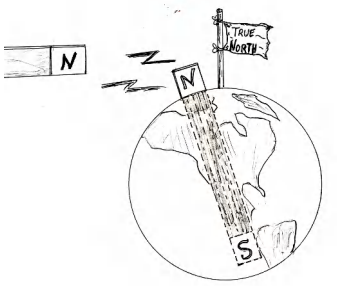
The ends or "poles" of a magnet are indicated as **North** and **South.**
The Rule about magnets is that
OPPOSITE POLES ATTRACT each other.



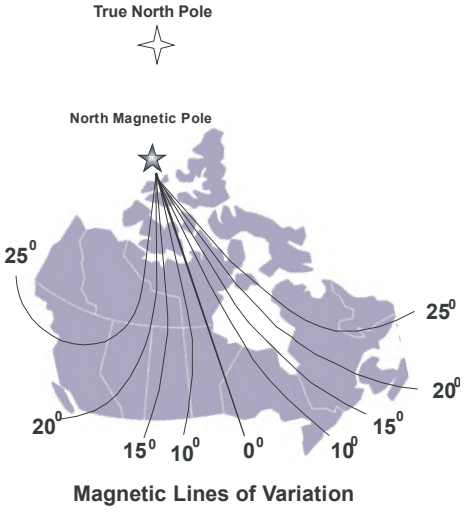
LIKE POLES REPEL each other.



The Earth is a giant magnet. **Because the <u>NORTH</u> SEEKING END**
of a compass points to the earth's magnetic pole-
the earths pole is *called* the NORTH MAGNETIC POLE.



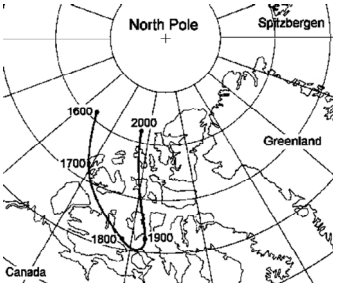
This picture shows the approximate location of the **North Magnetic Pole** in relation to the **North Geographic Pole.**
In Saskatchewan the average is 12-15° difference or "Variation"



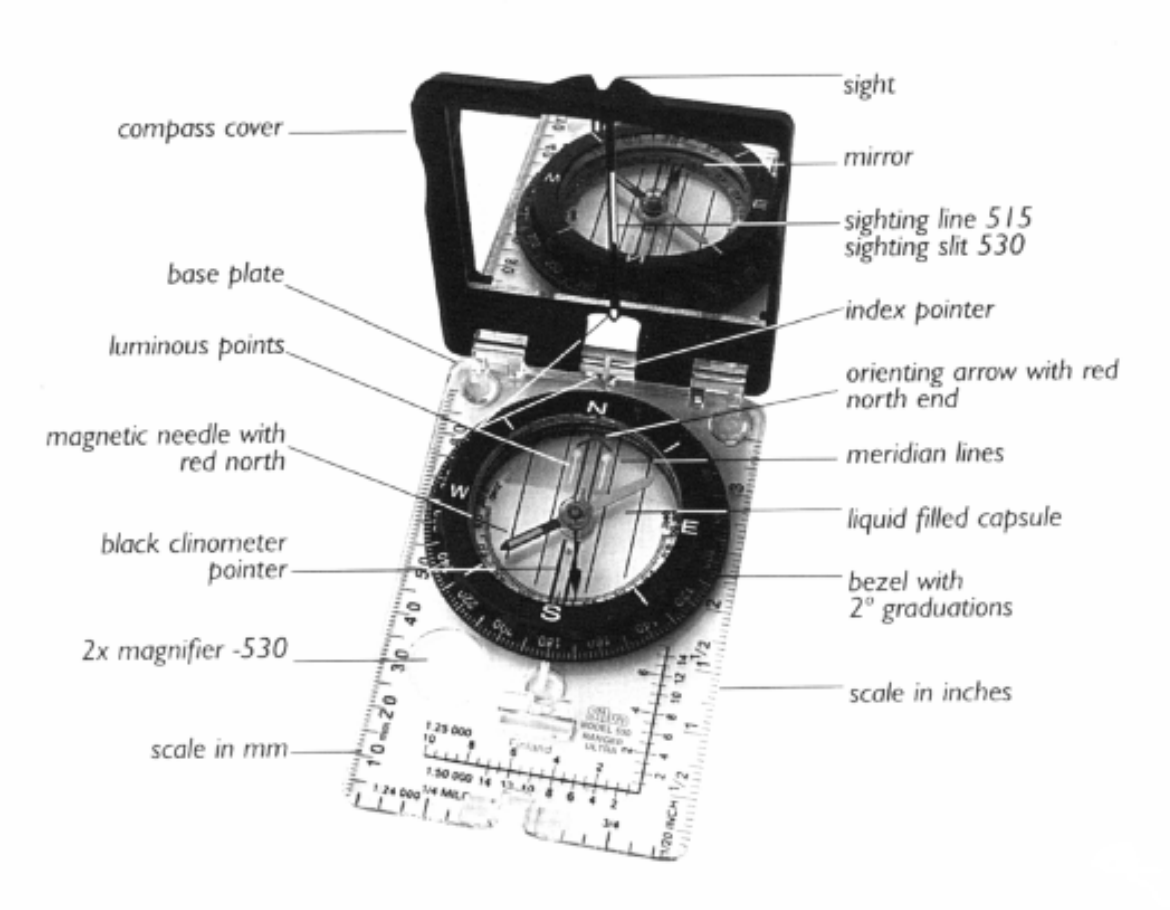
Magnetic Lines of Variation

The magnetic intensity varies within the areas shown. Near the magnetic pole magnetism is strong and pulls the compass needle downward making it difficult to take readings.
At the Equator the effect of magnetism is much weaker and
a compass tends to be sluggish and is more easily influenced by
nearby metal, magnetic fields or iron deposits.

This picture shows how the magnetic pole moves.
The North Magnetic Pole moves northerly about 15 miles per year.



PARTS OF A COMPASS
THE RANGER 515 AND 530

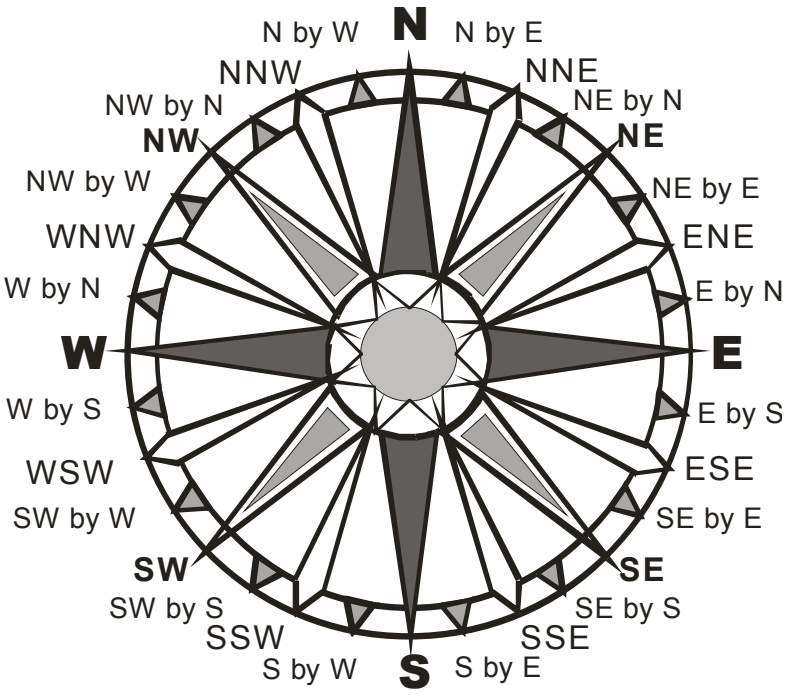


Not shown is the adjustable lanyard (cord for hanging around your neck)

BOXING the COMPASS

Before the Magnetic Compass was discovered, map makers would draw a "Wind Rose" on a map. This was a circle with 16 points on it. The points were the direction from which the "wind rose" or came from. ("The wind rose in the north-west this morning") When the compass came along the map makers placed it over the "Wind Rose" and it became known as the "Compass Rose". (anything ornamented or a graduated circular thing was known as a rose - from the flower) **Today some people refer to it as the "Azimuth Ring" or the "Graduated Dial".**

The "Compass Card" on a compass or the "Compass Rose" on a map is a circle made up of 360 degrees with North being 0° or 360°. East is 90° - South is 180° and West is 270°.
North, East, South and West make up the four main or "**Cardinal Points**".(Cardinal meaning first or fundamental) Half way between each cardinal points are the four - **"Intercardinal Points**". They are Northeast, Southeast, Southwest, and Northwest. Cardinal and Intercardinal points together divide the compass into 8 parts of 45° each.. Each of these may be subdivided or "halved" into 16 points.....of 22 1/2° each, which may in turn be subdivided or "halved" as well, to make a total of 32 points (each point is 11-1/4 °) as shown in diagram below. **Naming the 32 points of a compass in a clockwise order is called "Boxing the Compass".**



BOXING THE COMPASS

Direction	Symbol	Degrees	Direction	Symbol	Degrees
North	N	0(360)	South	S	180
North by east	N by E	11.25	South by west	S by W	191.25
North-northeast	NNE	22.5	South-southwest	SSW	202.5
Northeast by north	NE by N	33.75	Southwest by south	SW by S	213.75
Northeast	NE	45	Southwest	SW	225
Northeast by east	NE by E	56.25	Southwest by west	SW by W	236.25
East-northeast	ENE	67.5	West-southwest	WSW	247.5
East by north	E by N	78.75	West by south	W by S	258.75
East	E	90	West	W	270
East by south	E by S	101.25	West by north	W by N	281.25
East-southeast	ESE	112.5	West-northwest	WNW	292.5
Southeast by east	SE by E	123.75	Northwest by west	NW by W	303.75
Southeast	SE	135	Northwest	NW	315
Southeast by south	SE by S	146.25	Northwest by north	NW by N	326.25
South-southeast	SSE	157.5	North-northwest	NNW	337.5
South by east	S by E	168.75	North by west	N by W	348.75

TAKING A COMPASS SHOT
MAGNETIC – 0° VARIATION

This is probably the hardest part of Compass work…..taking a "Compass Shot" or "Heading" or "taking a Bearing". It is like trying to pat your head and rub your tummy at the same time……

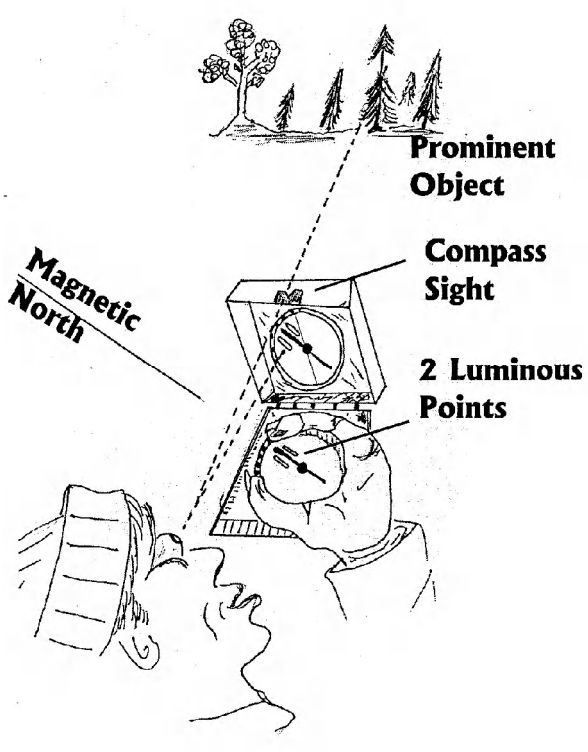
STEP 1. Pick a **prominent object** that you want to "take a Compass Shot on"

STEP 2. Hold up the compass and adjust the mirror so you can see the "**prominent object**" through the sight on the lid….. and at the same time see the compass needle and the **bezel** (the ring of degree markings).

STEP 3. Now rotate the **bezel** until the compass needle is between the two luminous points…. at the same time keeping the **prominent object** lined up with the sight and the **index pointer**.

STEP 4. Check and recheck to make sure the needle is exactly between the two luminous points, is swinging freely, and the lubber line or **index pointer** is pointing to the object you are trying to "shoot".

STEP 5. Now without disturbing the bezel, lower the compass in order to see the reading in degrees as indicated by the lubber line or **index pointer**.



….see next page…..

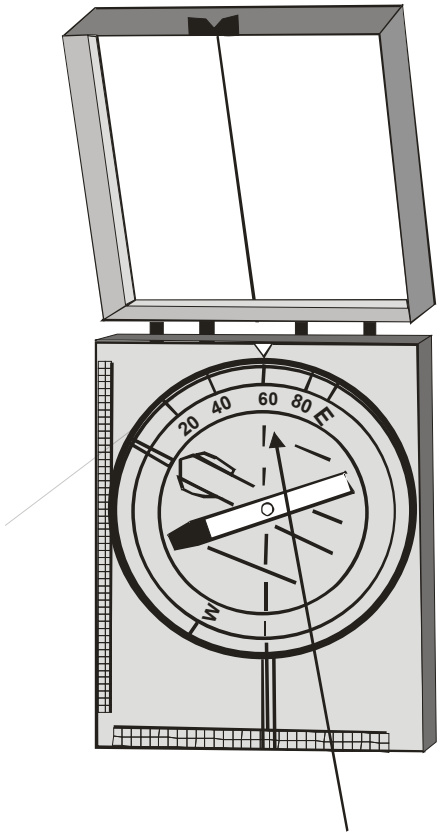
TAKING A COMPASS SHOT
MAGNETIC – 0° VARIATION

Look carefully …. You should be able to determine the reading within 2 or 4 degrees. Whatever the **Bezel** indicates…… that is the number of degrees or heading **from you to the object.**

THIS BEARING or HEADING is in <u>degrees **MAGNETIC**</u> …. Not to be confused with a
Map Heading, True Heading or True Bearing.

This gives you a heading or direction of travel to take, if you are working in **MAGNETIC HEADINGS.**

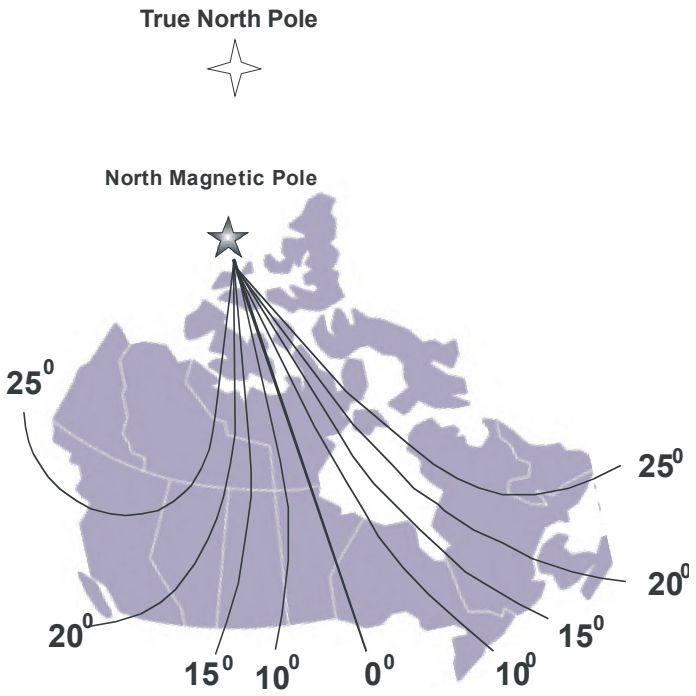
To work in True or Map Headings, turn to the page …….
TAKING COMPASS SHOTS – TRUE BEARINGS



Read the "Bearing" in degrees as indicated by the Lubber Line or Index Pointer (60°)

Variation - Declination

VARIATION ....DECLINATION.....are interchangeable words...they mean the same thing.
As we know the Magnetic North Pole is about 500 miles from the True North Pole or Grid North. That means that in Canada a line drawn between the True North and Magnetic North and extended down to the Equator would be line where the magnetic compass would also line up with the Grid or True North. (The same thing happens on the other side of the world too) This line in Canada runs through Cambridge Bay in the NWT and down just west of Lake Superior.
Lines of Variation are not straight, they curve and bend.



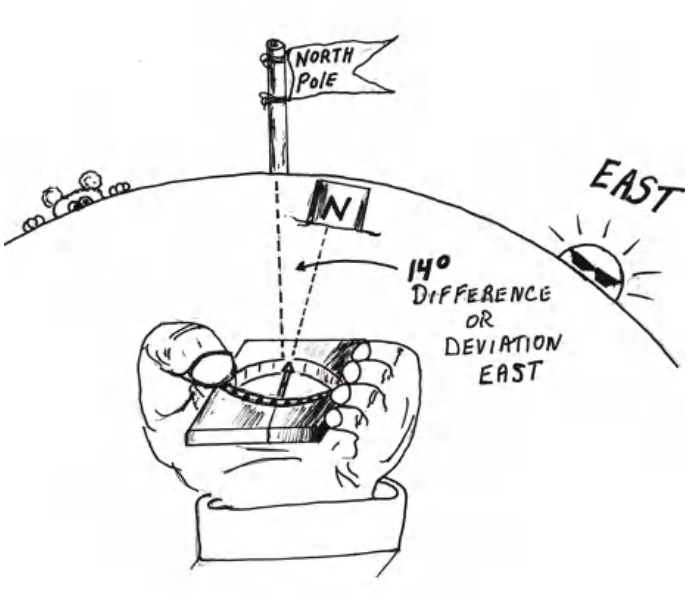
Magnetic Lines of Variation

As you can see the 5° East line of **VARIATION** (also called isogonic lines) runs just East of Lake Winnipeg. La Ronge in Central Saskatchewan is approximately 15° ***Easterly.*** Uranium City and Victoria B.C. both have a deviation of nearly 20° ***East.*** Anyone working East of Thunder Bay has to remembee they are **EAST** of the True and Magnetic 0° variation line and have to **SUBTRACT** the appropriate declination degrees from 360° when setting **VARIATION.**

DEVIATION usually refers to magnetic influences near the compass such as the body of a vehicle or nearby electrical wires. Refer to the section on DEVIATION for more information.

HOW DOES DECLINATION WORK IN SASKATCHEWAN ?

If you stand facing True North, the North Star at night or on a surveyed line that runs North on the map, you will find that if you take a compass reading, the needle will point to the **East** of your **True North Line**. This is because in Saskatchewan the North Magnetic Pole appears to be **East** or to our **right** when we face the True North. It is indicated on the maps we use, that **declination in this part of the world is EAST**.



EXERCISE:

FINDING MAGNETIC NORTH……THEN ALLOWING FOR VARIATION …FINDING TRUE NORTH!

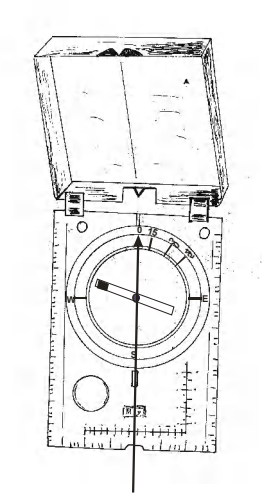
For this exercise, if you have a rotating Bezel or capsule, set 0° on the heading indicator, Lubber Line, or Direction Indicator line……

Have the compass needle pointing to the North Magnetic Pole. Once the needle is steady…. Rotate the compass and yourself until the **Index Pointer**, heading indicator, lubber line or Direction Indicator line is lined up with the compass needle. Sight down the line. ***You now have found Magnetic North!***

FINDING TRUE NORTH BY ALLOWING FOR THE VARIATION

EXERCISE:

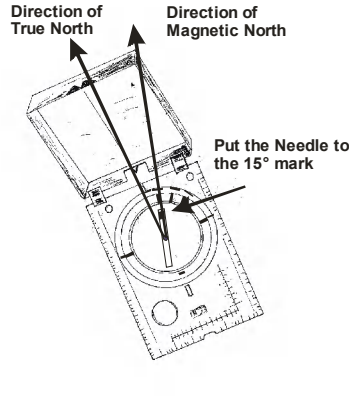
Finding TRUE NORTH by allowing for the VARIATION



Rotate bezel to 0°

Find out from other sources what the declination for your area is. Perhaps look at a map or maybe you already know the declination for the area you are in. To find True North you must SUBTRACT the declination or variation of your area from the magnetic bearing or heading.
Suppose the variation for your area is 15° East.

For this exercise, next step, have the rotating Bezel or capsule set 0° on the Heading Indicator.



You know the compass magnetic needle is actually pointing 15° to the right of True North, so now slowly rotate the compass, counterclockwise, until the **15° mark** is under or lined up with the compass needle.

Now the Heading Indicator is pointing to True North, the real North Pole!

CONGRATULATIONS, you have found TRUE NORTH!

If you know the **True North** Heading – **SUBTRACT** the Variation to get **Magnetic** Heading
If you know the **Magnetic** Heading – **ADD** the Variation to get **True North** Heading

CONVERTING MAGNETIC HEADINGS TO TRUE HEADINGS

WARNING*:** *This only applies to* ***EASTERLY VARIATIONS
When you are WEST OF ONTARIO

The best way to remember is **MAT** ..... **M**agnetic **A**dd (variation for) **T**rue
MATH ..... **M**agnetic **A**dd (variation for) **T**rue **H**eading
CAT..... **C**ompass **A**dd (variation for) **T**rue
MADE TRUE .. **M**agnetic **A**dd **DE**clination for **TRUE**
TRULY MAD.. **T**rue - **M**agnetic **A**dd **D**eclination

Examples: 90° Magnetic heading converted to True ..... **ADD** the declination (15°) = 105°**T**
160° Magnetic heading converted to True ..... **ADD** the declination (15°) = 175°**T**
320° Magnetic heading converted to True .... **ADD** the declination (15°) = 135°**T**

Converting True Headings to Magnetic Headings

The best way to remember is **TSM** ..... **T**rue **S**ubtract (variation for) **M**agnetic
TRUE Men **S**eek **V**irgins....**True** to **M**agnetic **-S**ubtract **V**ariation

Examples:
A heading of 90° True converted to Magnetic ...**Subtract** the declination (15°) = 75°**M**
A heading of 160° True converted to Magnetic... **Subtract** the declination (15°) = 145°**M**
A heading of 320° True converted to Magnetic ...**Subtract** the declination (15°) = 305°**M**

REMEMBER: *When you are* ***EAST of MANITOBA*** *and have* ***WESTERLY VARIATION****, the* ***opposite*** *conversions apply*

MEMORY AID

This memory aid only works for Easterly Variations.
Think of being at the **Magnetic North** Pole 78° latitude and you want to go to the **True North** Pole at 90° latitude, you would have to **ADD** or walk up to get there.

To convert do the "**MATH**" – **M**agnetic **A**dd for **T**rue **H**eading,

Converting **True** to **Magnetic**, you have to walk down or **SUBTRACT**.
"MAST" – **MA**gnetic **S**ubtract (variation for) **T**rue

MEMORY AID
Converting **MAGNETIC HEADINGS to TRUE**
(this only works when you are west of Ontario)

Imagine you are athe the **Magnetic North Pole**, (78° North Latitude). To convert to a true headingyou have to travel Northward (upwards)
or ….
ADD the VARIATION to get to **True North** (90° North latitude)

Converting **TRUE HEADINGS to MAGNETIC**
(this only works when you are west of Ontario)

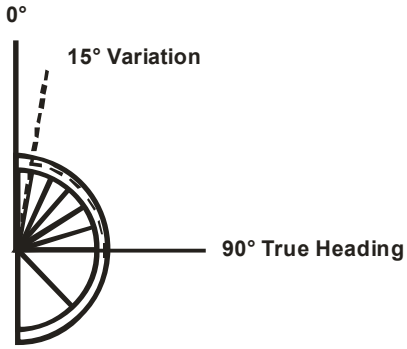
Imagine you are at the **True North Pole**, you have to come back down, or **SUBTRACT** the **VARIATION** to get **MAGNETIC.**

REMEMBER: the difference between the poles

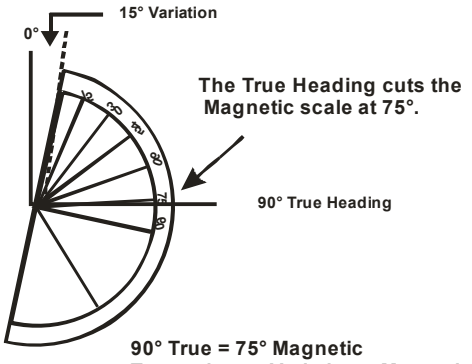
USING A PROTRACTOR

Practice drawing angles and use a protractor or your compass to convert True and Magnetic headings back and forth as illustrated below.

Draw a 90° heading as illustrated
Then draw a line representing 15° East Variation
using a protractor



Overlay a protractor on the line of variation.
Notice that the true heading of 90° is the same as 75° on the protractor.

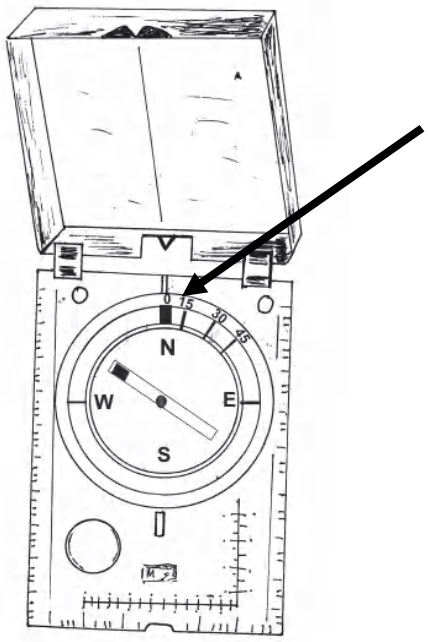


90° True = 75° Magnetic
True subtract Variation = Magnetic

SETTING DECLINATION

If you are fortunate enough to have a beter quality compass, it will likely have a set screw or some means of setting the **DECLINATION**, for the area you are working in, without having to constantly make calculations. The **Silva Ranger** depicted here, has a set screw on the bottom which may be turned by a small screw driver attached to the lanyard. Some compasses such as the **Brunton** have the screw on the top of the bezel.

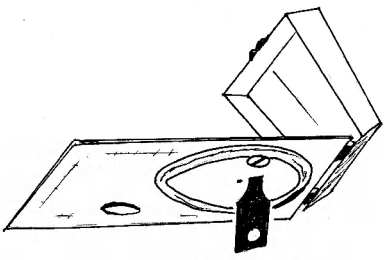
EXAMPLE: **to set the compass for a constant variation of 15°**



Set **NORTH** on the **INDEX POINTER** or Lubber line

Step 1. Look at the top of the compass, rotate the **bezel** so North is ser to the **Index Pointer** (on the lubber line)

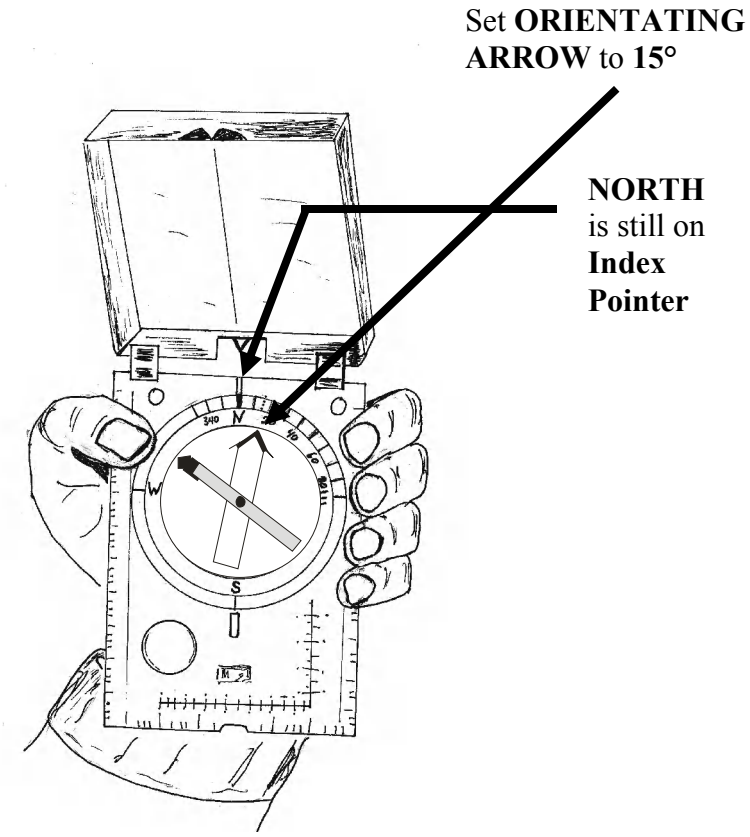
Step 2. Turn the compass over (if required)
Turn the set screw 1 or 2 rotations and then check to see how the Orientating Arrow has moved.



Turn the Set Screw on the underside of the Compass, using the supplied driver.

SETTING DECLINATION

Step 3. Adjust the **Variation set screw** until you have the desired Variation, in this case **15° East**.
North is still on the Index Pointer, but the **Orientating Arrow** will be pointing to the **15°** mark on the Compass Rose.



This is for **EASTERLY VARIATIONS**

To set for **WESTERLY VARIATIONS** follow the same steps, only adjust the **ORIENTATING ARROW** to the WEST of North., or to the left of North. If the Variation was **20° West**, you would adjust the **ORIENTATING ARROW** to point to **340°.**
(360° - 20° = 340°)

TAKING COMPASS SHOTS
TRUE BEARINGS

If you have mastered taking **MAGNETIC COMPASS SHOTS**, taking true compass bearings will be a snap, provided you have a compass in which you can set the variation.

Before you begin, set the variation for the area you are working in. The rest is identical to taking a magnetic compass shot because the compass now compensates for the declination you put in!

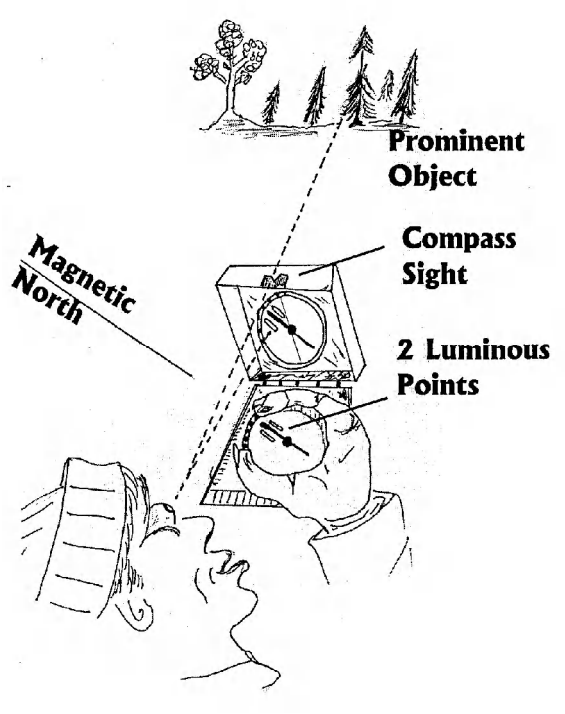
STEP 1. Pick a "**prominent object"** that you want to "take a compass shot on"

STEP 2. Hold up the compass and adjust the mirror so you can see the **"prominent object"** through the **sight** on the lid…….and at the same time see the **compasss needle** and **bezel**. (the ring of degree markings)

STEP 3. Now rotate the **bezel** until the **compass needle** is between the two **luminous points**….at the same time keeping the **prominent object** lined up with the **sight** and **index pointer**.

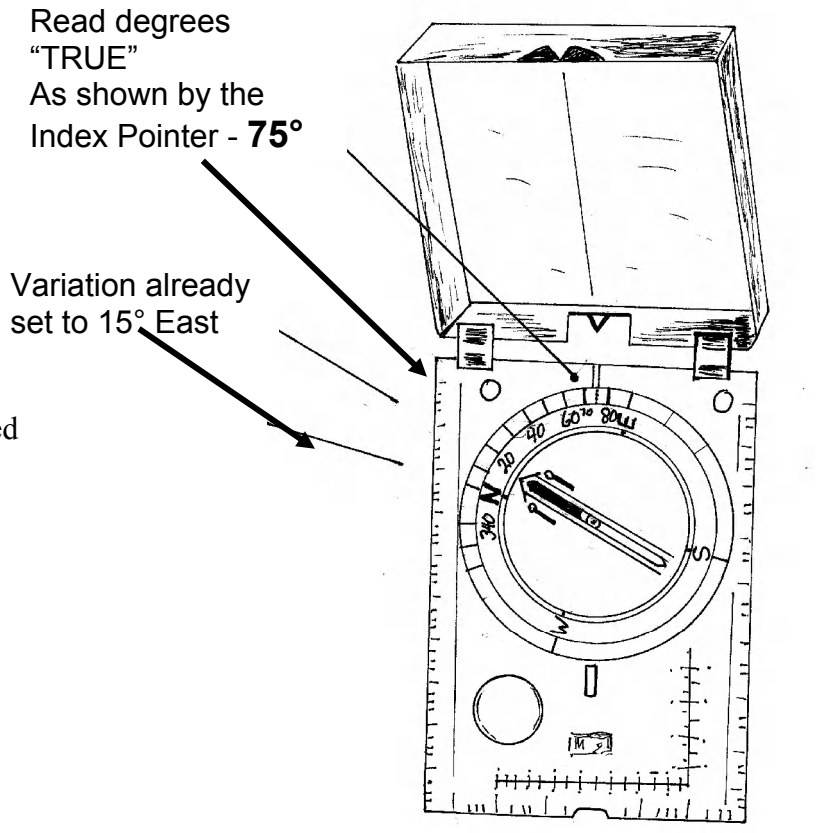
STEP 4. Check and recheck to make sure the needle is exactly between the two luminous points, is swinging freely, and the **index pointer** is pointing to the object you are attempting to "shoot".

STEP 5. Now without disturbing the **bezel**, lower the compass in order to see the reading in **degrees** as indicated by the **index pointer.**



TAKING COMPASS SHOTS
TRUE BEARINGS

Look carefully…. You should be able to determine the reading within 2 or 4 degrees. Whatever the bezel indicates, that is the number of degrees or heading from you to the object.



This **Bearing** or **Heading** is in **<u>Degrees True</u>** ….not to be confused with magnetic headings.

This reading gives you the heading to take, if you are working in **TRUE** headings or bearings.

*The compass needle always points to the North Magnetic Pole. You set the compass needle directly over the Orientating arrow, however, because you previously set or added the variation (15°) , the **N** on the bezel points to the True North Pole.*

Your prominent object in the diagram above is on a bearing of 75° True
(60° Magnetic + 15° variation = 75°

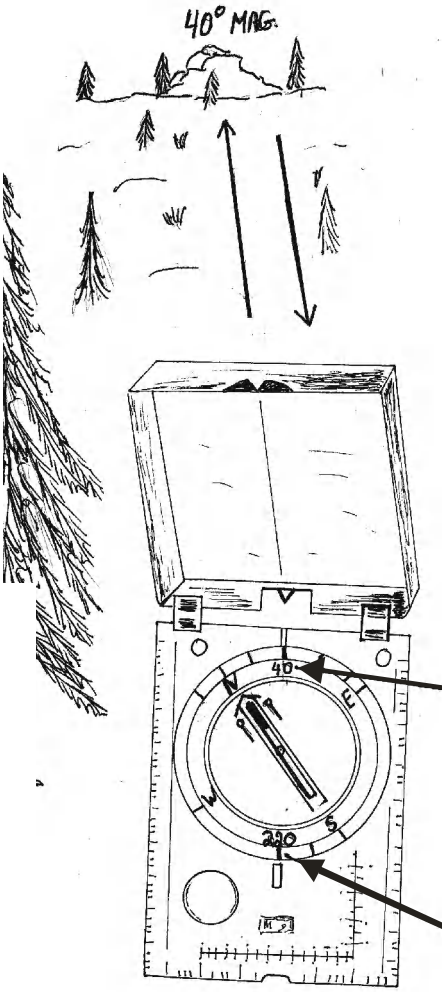
BACK COURSE - 180°

PROBLEM # 1.

You are standing beside a tall lone pine tree and you take a bearing on a large rock that is one kilometer away. You know when you get there you will want to come back to the tall lone pine tree. If the rock was on a heading of **40° magnetic** from you, what heading would you take in order to get back to the tall lone pine tree?

ANSWER:

To find the **"back course"** or **"get a back bearing"** or to **"make a 180"** (aeronautical term ` for turning around and going back - 180°) simply find your **compass heading** indicated by the index pointer on the compass rose and then look directly across to the **opposite** side of the compass rose (180° away) (sometimes called the reciprocal)



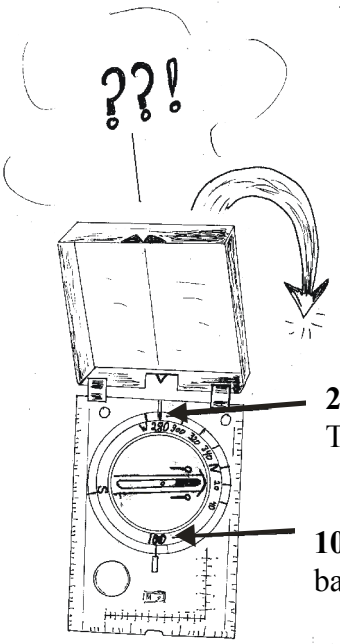
Present Heading 40° M

Reciprocal or Back Course – look for degrees opposite to the heading –this is your new heading to get back - 220°

Back course*.....the heading to take to return from whence you came....*

NOTE: if you have already set your compass with the variation, you would be working in **TRUE** headings and the procedure is **EXACTLY** the same.

BACK COURSE - 180°



PROBLEM #2.
You are heading across the lake on a skidoo, on a heading of 280° True. A sudden snow storm comes up and you encounter a white out and have to return. What heading would you now take?

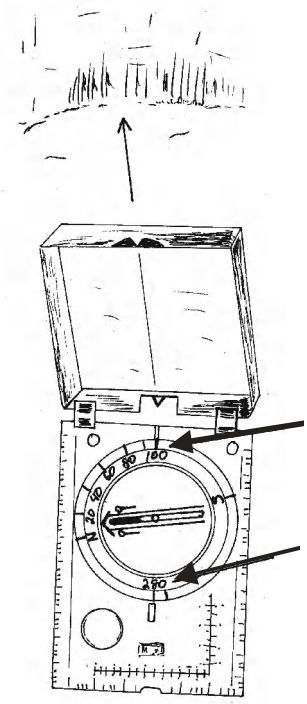
ANSWER:
Look for the opposite or reciprocal of 280° (which is **100 °)** This is the heading you take to return home.

Now that you know what the new heading is, you want to set your compass to make easy to follow by the following steps….

STEP 1.
Turn the bezel until **100°** is now on the **Index Pointer**.

STEP 2.
Turn yourself around half a turn and center the compass needle over the **Orientating Arrow.** The **Index Pointer** now indicates the direction of travel to retrace your back course.

*The headings in this example are in **TRUE** with a declination of **15° E** adjusted in the compass already*



Turn around so the compass needle and Orientating Arrow line up. You are now on the back course heading 100° True

FOLLOWING A HEADING

Sometimes you are given a **heading** or **bearing** to follow or you may have determined the heading from reading a map

Following a heading is easy.
For example: if you were to follow a heading of **220°**

STEP 1. Rotate the bezel until **220°** is indicated on the index pointer.

Step 2. Now rotate yourself and the compass until the compass needle and the orientating arrow are lined up.

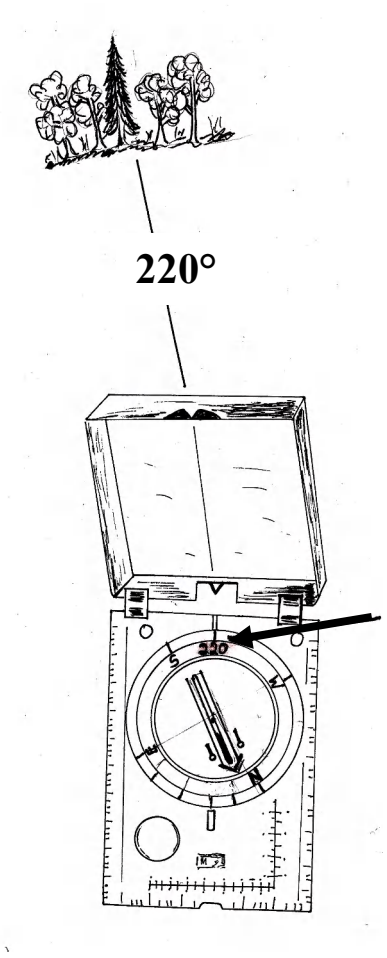
STEP 3. Use the compass sight to pick out prominent object in the distance that you ca travel to.
Check and be sure the compass needle and the orientating arrow are still lined up.

STEP 4. Travel to the object you chose. When you arrive take another "shot" on another prominent object, still using the sam original setting of **220°.**

STEP 5. Repeat the process as necessary until you reach your final objective.

NOTE: depending on the terrain you may have to take "shots" every few feet. Just be sure to choose an object each time that you can find!

If you can't find your object….what heading do you use to get back to the last known location ???



Rotate bezel until the heading you were given is indicated – **220°**

Now rotate the compass until the compass needle and orientating arrow line up. The **Index Pointer** now shows the **direction of travel.**

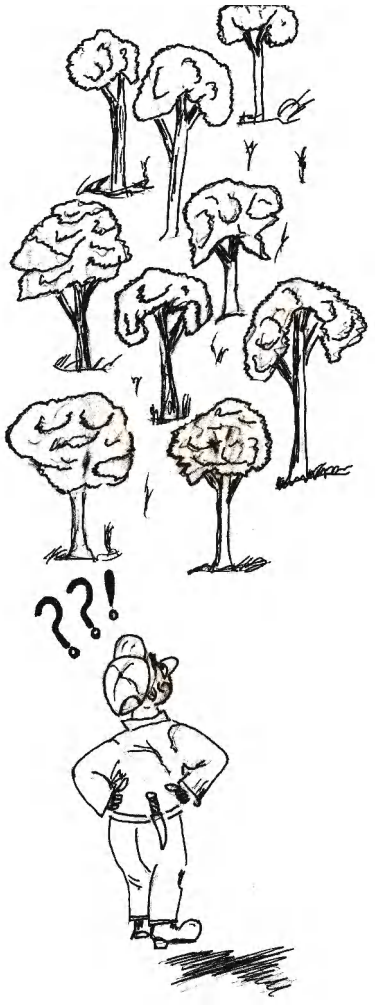
Pick a prominent object in the distance. Travel to the object and then take another "shot". Repeat the process as necessary.

BLAZING A LINE

It is a good idea to blaze tree when you are lost so searchers can find you. It is usually permissible to blaze trees if you are running a line where the trees will be cut and used afterwards. A tree can normally survive a cut through the bark if it is not too large or deep. The natural immune system of the tree will take care of a small light blaze. Hacking into a tree will cause damage. Normal blazing will show for many years. It is surprising how well a fresh blaze will show up at night.

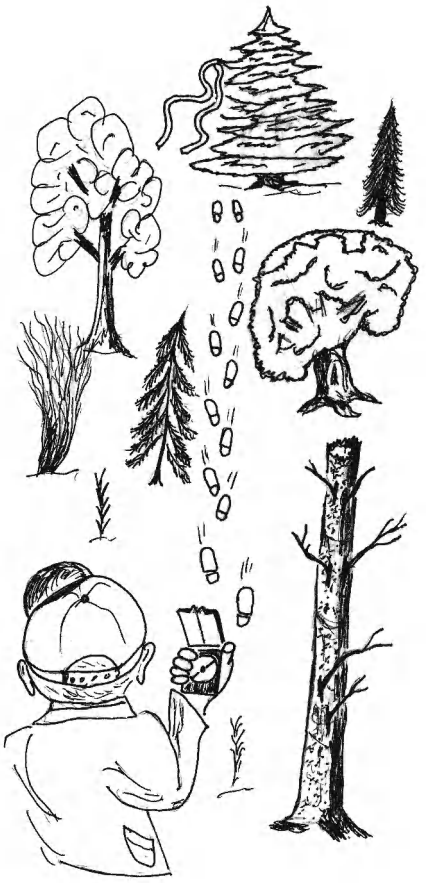
If you are blazing a trail and expect to return along the same line, you had better blaze both sides of the tree. Otherwise, you will end up like the poor fellow, when he turned around to go back, the blazes had all disappeared!

Coloured flagging tape is often preferred to blazing. Now even bio-degradable flagging tape is available.



REMEMBER: you can over-do-it with blazing and flagging, soon the woods are full of blazes; and coloured tape is everywhere!

RUNNING COMPASS LINES



One way for one person to run a compass line, is to set the **reciprocal heading** on the compass and then walk or **travel backwards**; continuously lining up with the last flag, flagging the present location, and then moving along until the last flag can be just seen. This can be very accurate if two or more flags are visible at one time. A variation of this would be to walk forwards for a ways, then turn around and take a shot; and line up again.

One person Compass Line – using reciprocal bearing – walking backwards

Compass work with **two people** is easier. One person can go ahead guided by the person with the compass. One a new point is flagged, the **compass person** can move quickly forward to it, at the same time the **flagging person** can also turn around and check for accuracy if two or more flags are visible.

Running Compass Line – 2 person

MAPS – WHERE ARE YOU?

Where am I ? If you have a map with you, try to identify some geographical features in the real worl, with the corresponding features shown on the map. This is not always possible. The more features you can see and identify the better.

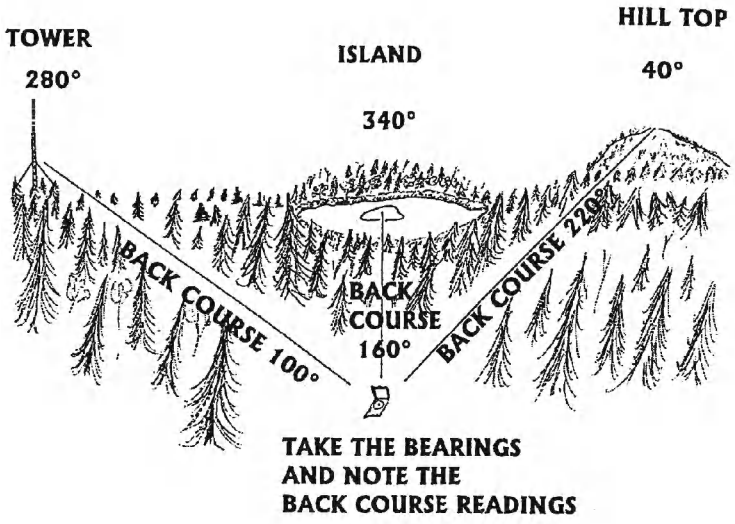
STEP 1. take bearings **TO** each selected feature. Note the back course or reciprocal heading. Three bearings work well.

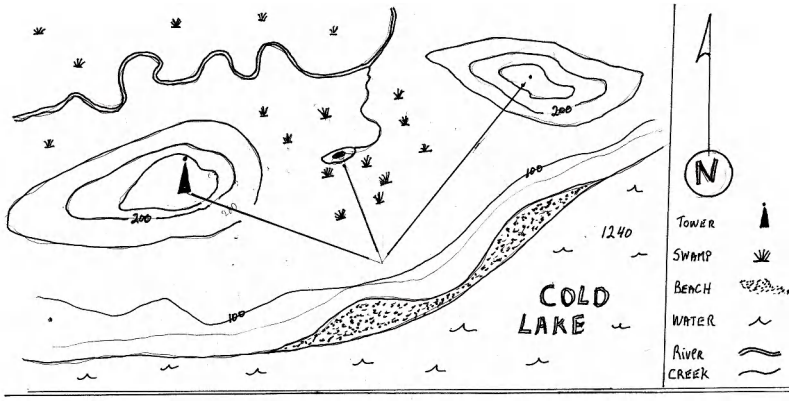
STEP 2. Locate each feature on the map that you "shot".

STEP 3. Using a protractor or your compass rose lined up with the map grid, draw the back courses or bearings **FROM** the features.

STEP 4. Where the lines cross, that is the location where you are!

NOTE: if the compass that was used had the variation set for the location then all the bearings are in **TRUE** automatically.





On the map, draw the bearings from the tower, island and hill top. Where the lines all meet is the location where you are. Because the compass had the variation already set, all the bearings are automatically in **TRUE.**

FINDING TRUE BEARINGS ON A MAP

You are at **Point A**. You want to go to **Point B**. What heading or bearing would you travel ?

STEP 1. Draw a line on the map from Point A to Point B.

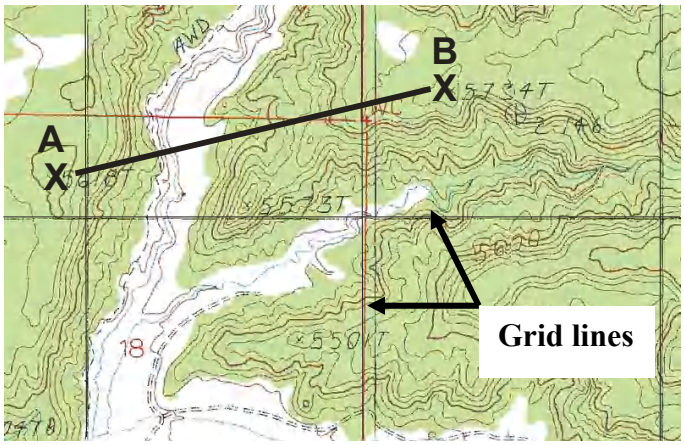
STEP 2. Set **NORTH** on the index pointer of your compass.

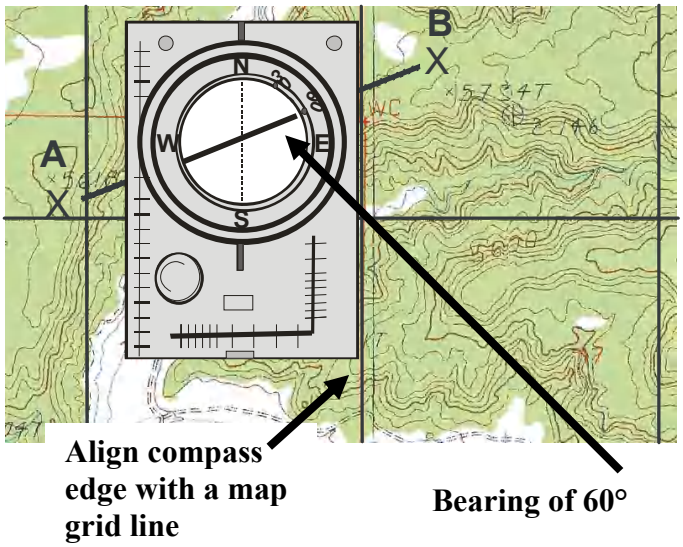
STEP 3. While looking through the clear plastic capsule, centre your compass over **Point A**. Now rotate the compass until the edge of the compass is parallel to some **grid lines** on the map.

STEP 4. Using the compass as a protractor, determine the number of degrees or the bearing to **Point B**. In this example it is **60°**.

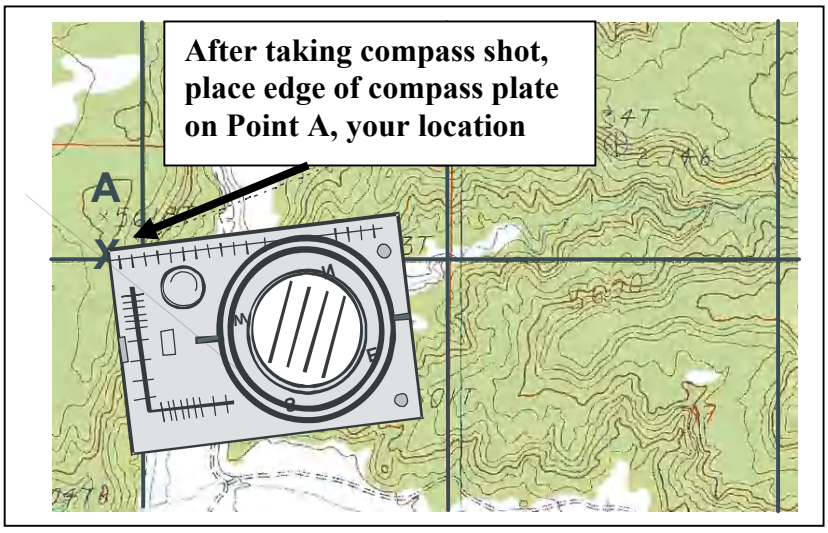
That is **60° True** bearing because it was aligned to the map grids which are in **TRUE.**

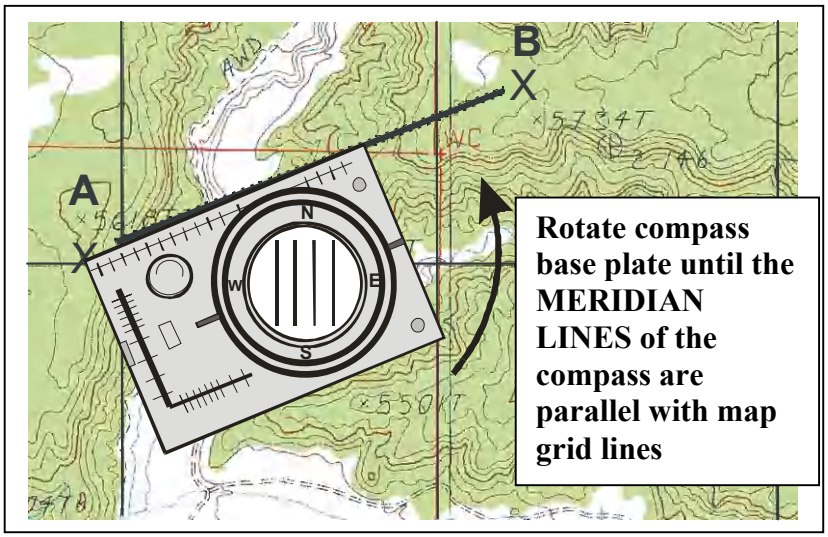
NOTE: *the compass needle and orientating arrow are not shown for clarity. The compass needle is not used to find a map heading.*





DRAWING A COMPASS SHOT ON A MAP





HOW TO DRAW A COMPASS SHOT ON A MAP

STEP 1. Mark your known location on the map **Point A**.
STEP 2. Take a compass shot on object you want to go to or draw a line on the map to.
STEP 3. Leaving the heading on the index pointer, place the edge of compass plate on the map at **Point A**, your location.
STEP 4. Rotate the compass base plate until the **MERIDIAN LINES** of the compass are parallel with **map grid lines.**
STEP 5. Draw a line along the base plate. Extend the line as required. Mark destination as **Point B** if you wish.
NOTE: *the magnetic needle is not used for this.*

PACING

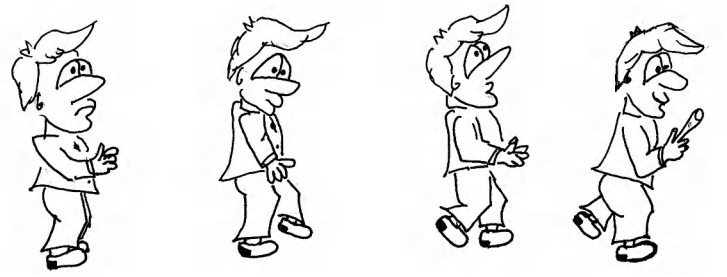
Did you ever wonder why a mile is a long as it is? (5280 feet) A mile is the distance a Roman foot soldier would cover with 1000 paces. The word "MILE" comes from the Latin "Mille Passus" meaning 1000 paces.

A **Pace** is the double step distance between two right foot steps. An average adult pace is 5 feet; an average older child is 4½ feet and a 10 year old 2½ feet.

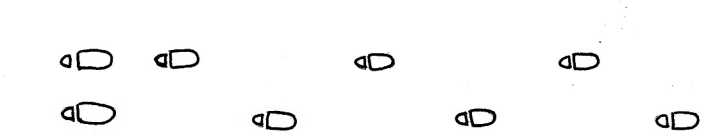
There are about 250 adult paces in ¼ mile, 500 paces in ½ mile.

Check your pace – measure out 100 feet on the ground. An adult should take between 18 – 21 paces to cover the distance.

Learn your pace distance……it will come in handy some day.



Start **Step forward with left foot** **Step down with right foot and count 1 pace**



Start **1 Pace** **2 Paces** **3 Paces**

*If it is more natural for you, you can do the same using your **left foot**. You would start with your right foot forward first and count every time your **left foot** landed.*

Learn how many paces it takes **you** to cover 50 meters.

Line cutting and survey work is often done with "chains". A chain is a nylon rope 50 meters in length with meters marked on it.

One Line Cutter knows that he takes **32 paces per 50 meters.**
His trick – is to break off and hold a short twig in his hand every 32 paces (50 meters). When he is finished measuring the line, he counts the twigs to see how many "50 meters". Other Line Cutters will stuff a short piece of flagging tape in their pocket for every 50 meters covered.

Wildland Fire Fighters use pacing to estimate the lengths of fire hose they will need.

1 mile = 1,609 meters	1 mile = 1760 yards	
1 meter = 3.28 feet	1 meter = 1.09 yards	1 meter = 39.37 inches

TRAVELING

The rate of travel over various terrain varies widely. There are many factors to consider when estimating travel time across country. Not only a persons physical condition, weather and unpredicted obstacles affect estimates of travel time but unforeseen problems often occur. Baring the unforeseen, anyone doing much traveling "in the bush" has a good idea how long a trip may take. The following are some guide lines that an average person may expect to encounter.

Rates of Travel carrying little or no items	
Gentle well maintained trails	4 – 5 kilometers per hour (2.5 – 3 miles)
Rough back country trails	3 – 4 kilometers per hour (1.8 – 2.4 miles)
Bushwhacking	2 kilometers per hour (1.2 miles)
Poor weather/whiteout conditions	2 kilometers per hour (1.2 miles)
For every 300 meters (1000 feet) elevation gained	Add 1 hour

	Factors which effect the Pace
Slopes	You will lengthen your pace going down hill and shorten your pace going uphill. If it normally takes you 64 paces to walk 100 meters, your pace may increase to 70 paces when walking up a gentle slope.
Winds	A headwind will shorten your pace and a tailwind will increase your pace.
Elements	Snow, rain or ice can cause the pace to be reduced in length.
Surface	Sand, gravel, mud, snow, and similar surfaces shorten your pace. They may even stop you.
Visibility	Poor visibility, such as fog, rain, darkness, will also shorten your pace.
Clothing	Excess clothing and boots with poor traction will also affect the length of your pace.

A responsible hiker needs to rest 15 minutes each hour to keep his legs dependable. When muscles consume energy, they give off a poison called lactic acid. The body can only deal with this in small quantities, so it stores the excess in the muscles. If the muscle has too much, it will cramp. It takes the body about 15 minutes to deal with about ½ the acid that is produced. It takes several hours to deal with the other ½. By stopping 15 minutes of each hour you will prevent a dangerous build-up.

A grade that is 5% or less is considered as "flat". A grade of 20% or less is considered a "hill". A grade that is more than 20% is considered "climbing"

Making 45° and 90° Turns

After you have marked your compass at 45°, 90°, 270° and 315° it is easy to make these turns. You no longer have to try to calculate your heading by adding or subtracting 45° or 90° to your current heading and remember what it is as you set the Index pointer.

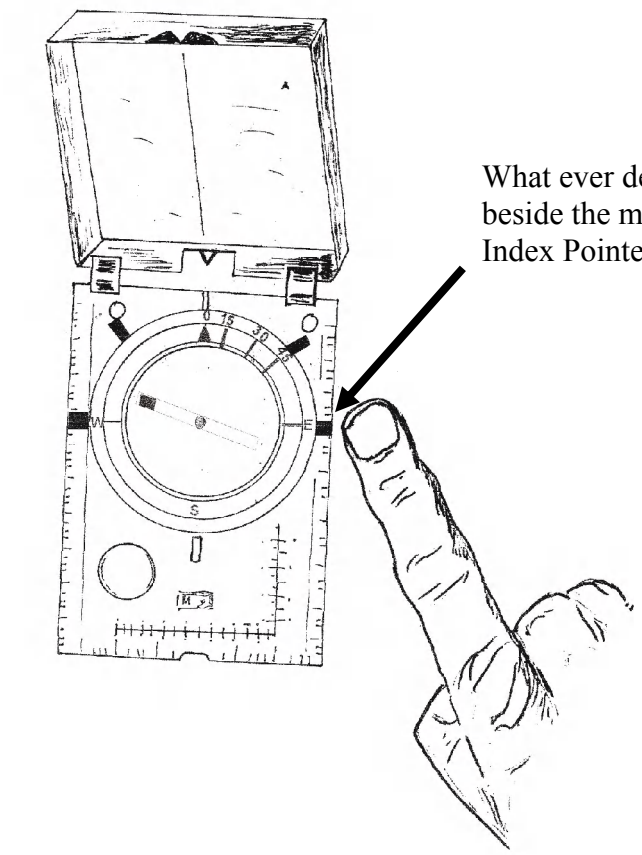
It's easy, to make a 90° turn to the right,
STEP 1. take your right index finger and place it next to the 90° mark you made on the compass base plate.

STEP 2. remember the number of degrees on the bezel next to the mark, turn this number up to the Index Pointer (using your right finger and thumb)

STEP 3. holding the compass level, turn your body to centre the needles, aim the compass, pick out a prominent object and away you go.

NOTE: to make a left turn 90°, use your left index finger, place it next to the 270° mark, and turn up what ever degrees are showing on the bezel. Follow the same procedure.

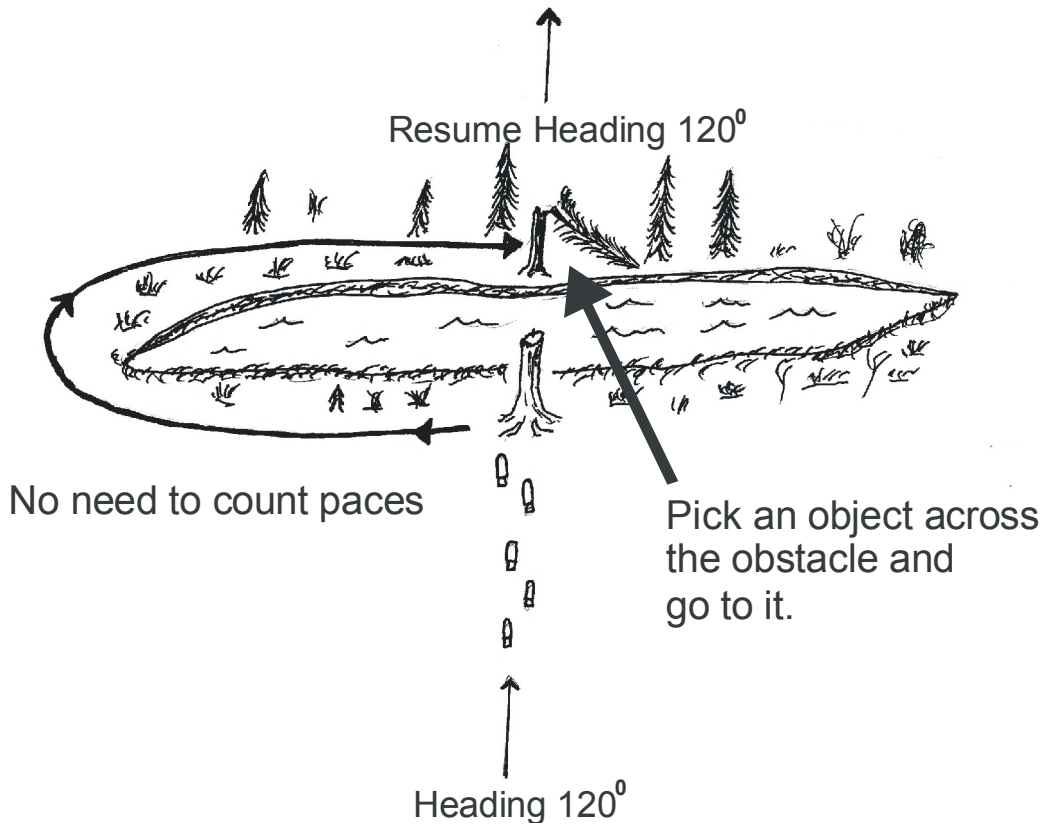
To do 45° turns, follow the same procedure using the 45° marks.



GOING AROUND OBSTACLES

When following a heading you will often come across obstacles that you have to go around. Things like rock outcrops, lakes, wet swamps and more. Shown here are two methods of dealing with obstacles.

Sighting Method
If possible, when you come to an obstacle that you can see across, simply tale a shot on an object in line on the far side. Now travel to the object and resume your heading.



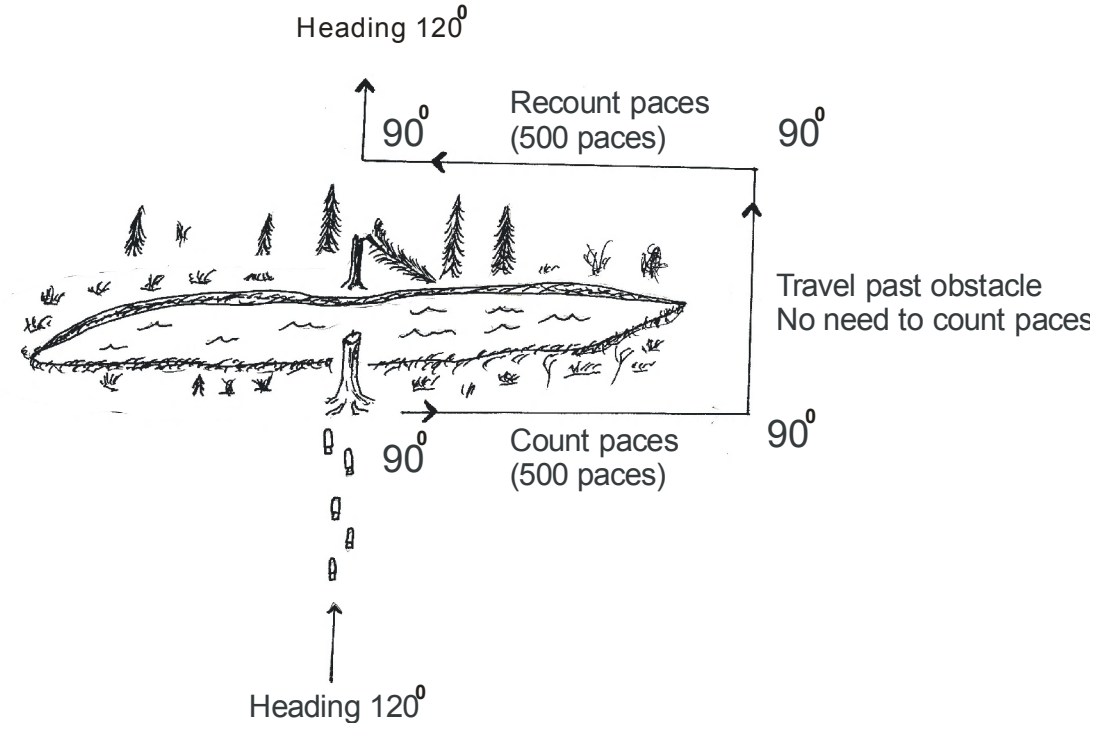
GOING AROUND OBSTACLES

Pacing Method

If you are unable to get a "shot" through the obstacle, you must now rely on your ability to count your paces. When If you are unable to get a "shot" through the obstacle, you must now rely on your ability to count your paces. When you encounter the obstacle –

1. Make a 90° turn either left or right and travel far enough to skirt the obstacle. Let's choose **right** for this example*. *You must count your paces as you go*. Remember how many it took.
2. Now turn **90° left** to original heading. Travel past the obstacle. No need to count this distance.
3. Turn **90° left** again to skirt the obstacle. You must now count down your paces to get back to a spot that is in line with original trail.
4. You are now at a spot in line with your original trail, you must now turn **90° right** to resume original heading.

* If you choose **left at first turn**, then you must make **2 right turns** and a **left.**



GOING AROUND OBSTACLES

Try the **"45° Bushwhacker"** or the **"Dog Leg"**
If you encounter an obstruction on your heading and you have to circumnavigate the obstacle, try the 45° Bushwhacker. To do this change your heading 45° either left or right some distance before the obstacle.

Count the paces you make until you are past the obstruction, now turn and head 90° back to your original intended path, counting down the same number of paces. This should bring you back to a point along your original intended path. Take another shot using your original bearing and continue on.

Mathematically you would take your heading of
330° add 45° to get 375° or 15°

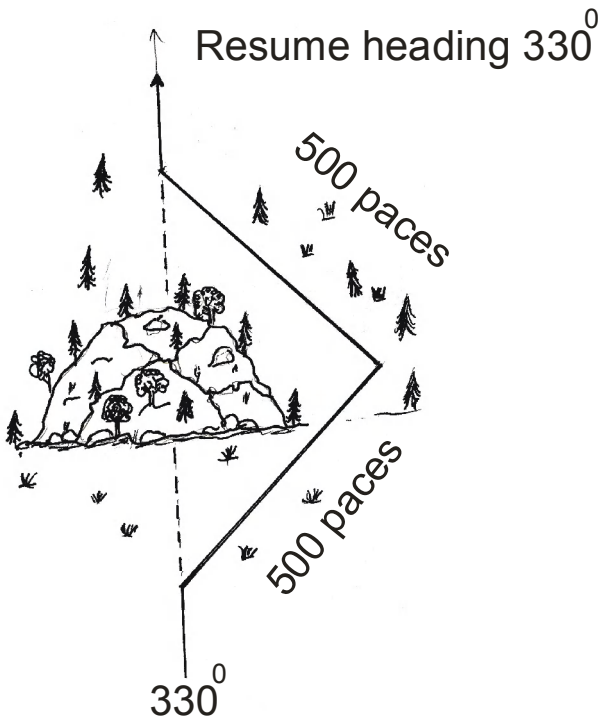
Set **15°** on your index pointer and follow your compass heading for **500** paces.

Once past the object
Subtract 90° from 15° to get 285°

Now follow your compass heading **285°** for **500** paces.

Return the original heading **330°** to the index pointer and continue on.

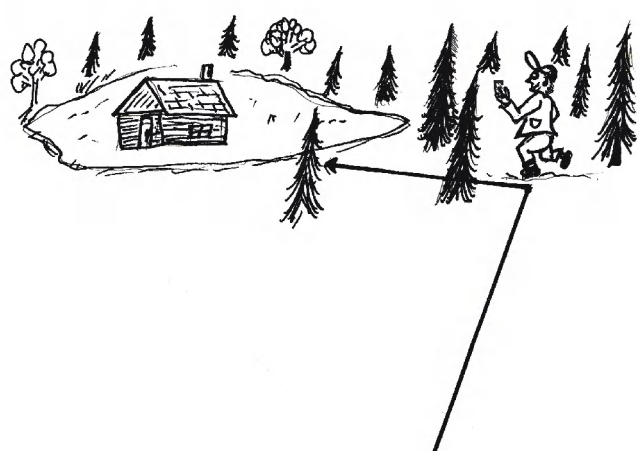
Instead of trying to do calculations, just count out the degrees on the compass rose and then set the index pointer to the degrees.



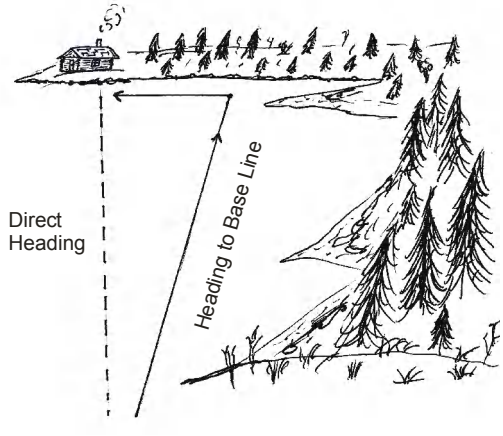
AIMING OFF

Aiming Off, aiming off to one side. It is almost impossible to travel to an exact heading. Often you can be 5° or more off course. On a long course you may even miss your target. One trick is to deliberately aim left or right of your target. Then you will know whether to turn left or right when you are in the vicinity of your objective.

If you aim directly at your destination and you are out a few degrees, you don't know whether to turn left or right when you are near.



If you aim 2° - 5° to the left or right of your intended destination, when you have traveled the estimated distance, now you will know to turn left or right to search for your objective.



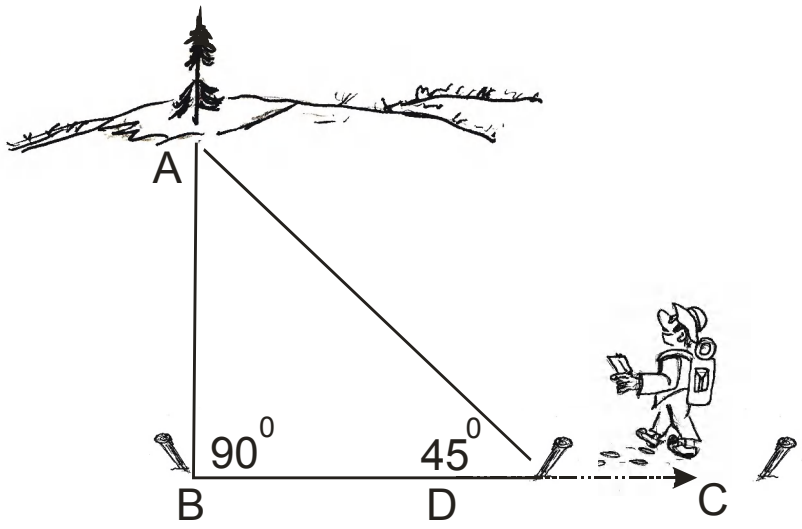
Instead of heading directly to your destination with a chance of missing it, use a Base Line such as the shore line. Use the shore line as a guide to the objective.

BASELINES

If there is some kind of baseline near your objective, aim for it and use it to guide yourself into your objective. Use a baseline to "fence yourself in". You may combine this with Aiming Off in order to know which direction to turn when you get there.

Some times baselines are referred to as "Handrails" "Natural boundaries"
Some examples are, rivers, roads, lakeshores, hills, valleys, eskers, you get the idea.

MEASURE DISTANCES – 45° METHOD

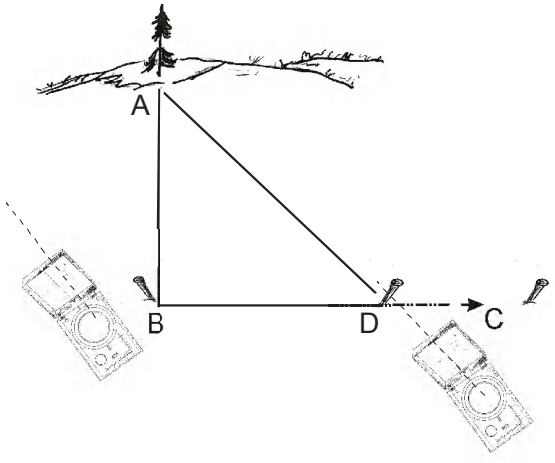


To find the distance between two objects, in this example the tree (point A) and a stake (point B), you start by creating a baseline. (B-C)

From the stake (point B) run a compass line 90° to A–B and mark with a stake (point C).

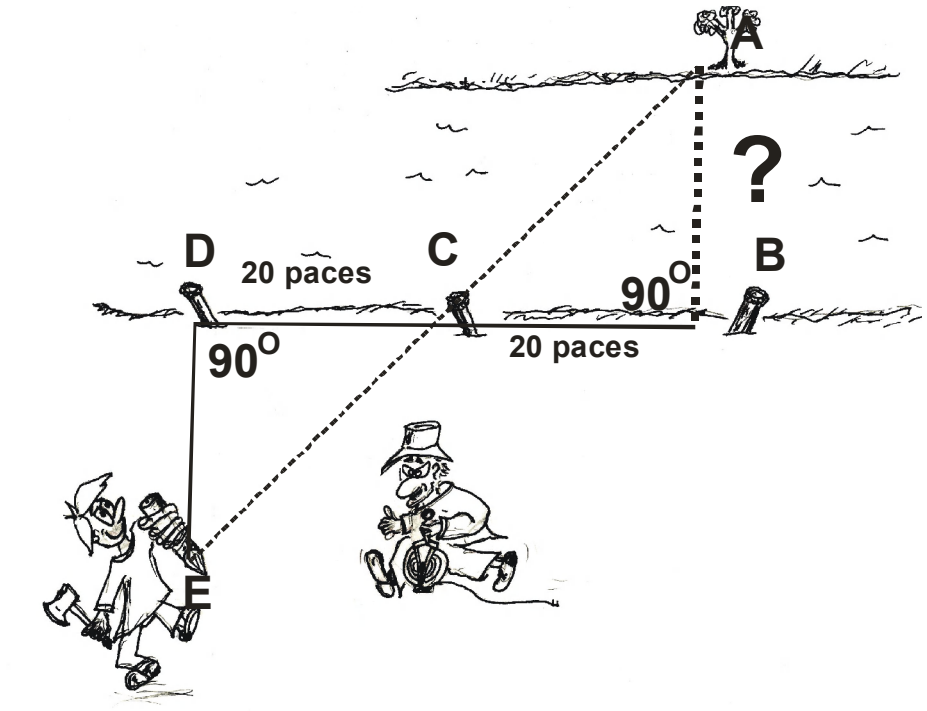
Now using your compass - start at point B and move along the baseline B-C until you are at a point that forms a 45° angle with point A. If the baseline was a heading of 300° (actually C-B) set index pointer on 300° + 45° = 345°. With the compass needle and orientating arrow centered as you move along B-C there is a point where sighting the compass will show point A. At this point pound in a stake (point D).

Now measure the distance B-D, this is the same distance as B-A.
You can use feet, meters, yards or paces.



Geometrically you are producing an isosceles triangle that has two sides the same, therefore if you measure B-D it is the same length as B-A.

MEASURING ACROSS A RIVER



To measure across a river – pick a point on the opposite side. (point A). Now put a stake on your side of the river (point B).

Using your compass run a base line 90° from A-B for a convenient distance, For example 20 paces, and put in a stake point C. Continue on same baseline and go another 20 paces and put in a stake point D. (B,C and D are in a straight line)

At point D make another 90° and move towards a point E.

At a point where points E and C and A all line up, put in stake E.

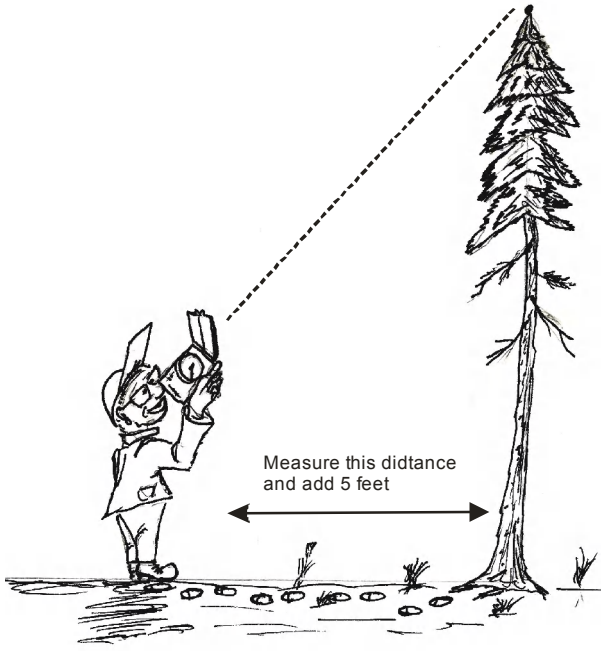
Measure the distance E to D and that is the distance across the river.

B and D must be 90° corners, C has to be exactly half way between D and B.

Use any unit of measurement, feet, yards, meters or paces.

Geometrically you are producing a mirror image triangle on your side of the river. All you have to measure is D-E because it is the same as B-A. B-C and C-D can be any convenient measurement, but it is critical that they be exactly the same. This does take up as much room on your side of the river as the river is wide.

MEASURING HEIGHT WITH THE INCLINOMETER



To measure the height of a tree – set the compass with **WEST** or **270°** on the index pointer.

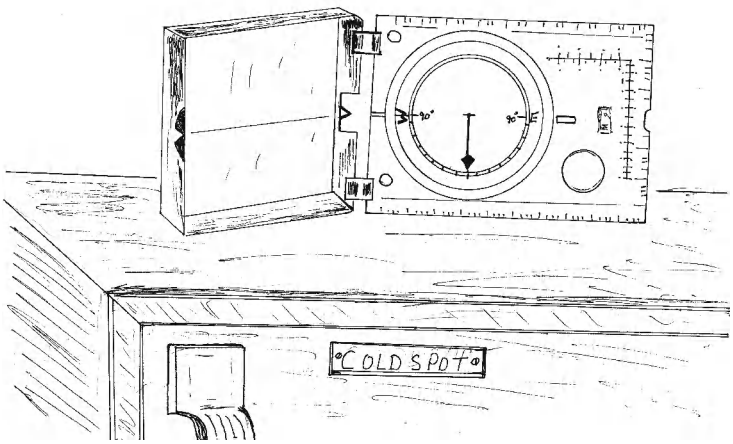
Hold the compass on it's side so the inclinometer swings freely. Adjust the mirror to be able to sight the tree top along the edge of the compass base plate and be able to see the inclinometer pointer at the same time. Angle the edge of the compass until you can see the pointer at **45°** in the mirror.

Walk away or towards the tree, sighting along the edge of the compass until you reach a point where the compass edge lines up with the tree top and the inclinometer needle is on **45°**

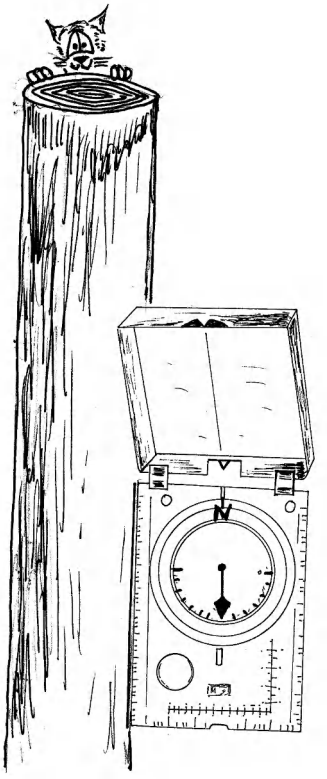
Measure the distance from this point to the tree. Add **5** feet to the distance to get the tree height.

You have to add 5 feet or what ever height above ground you held the compass.(6 feet?)

INCLINOMETER AS A LEVEL



With **WEST** (270°) set on the index pointer the compass can be used as a carpenter's level. This works well for checking grade on a sewer line, leveling a camper, leveling appliances and many other uses.

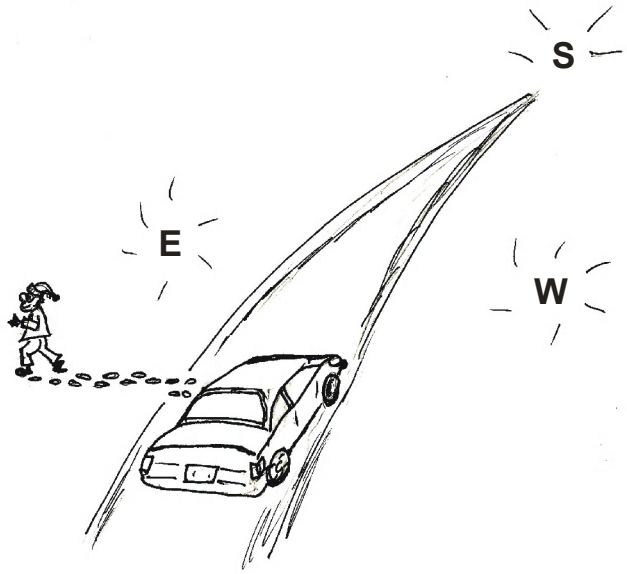


The inclinometer works well for plumbing vertical objects. Set NORTH on the index pointer and use as you would a carpenter's level. This works well for putting in sign posts, fence posts and anything that needs to be vertical.

COMPASS HINTS

Be sure to check your compass and take a reading **BEFORE** you leave your vehicle. That way you will have a general idea which way to head in order to return.

Always keep a mental map in your head.



Stay 10 – 20 meters away from a car or truck, power lines or fences.
Stay at least 1 meter from a gun or rifle.

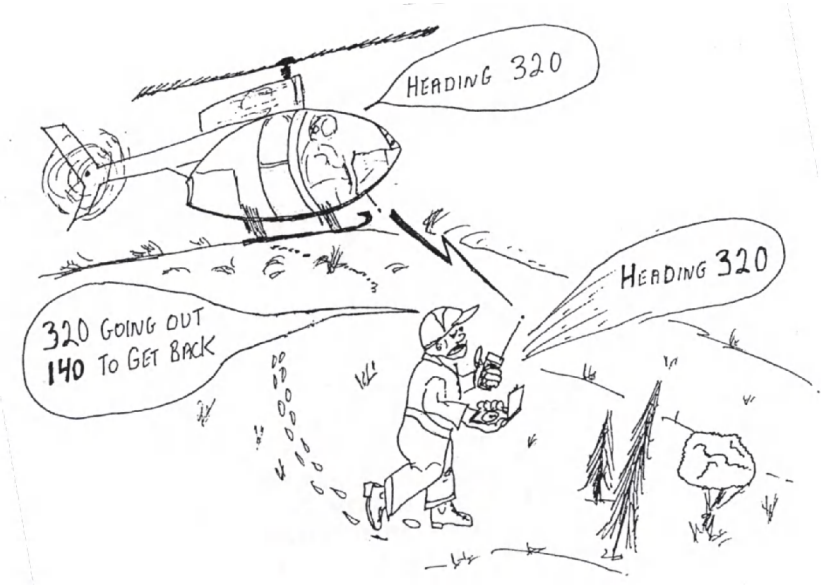
I'd like to remind you of a very important compass fact.
Compasses are a magnetic source! Not so earth-shattering, right? Well it can ruin your whole day if you forgot and put your compass in the same pocket or bag as a computer disk, a magnetic ID card, a CD tape, near a camera or light meter, on a television set, near a computer, etc, etc, etc. Not only can a compass severely damage passive magnetic media; it can be damaged by active electronic devises that produce strong magnetic fields. Effects are unpredictable.

High temperatures above 140° can expand the compass capsule and cause it to leak. Low temperatures and low barametric pressure can cause bubbles to appear. They do not effect the accuracy and usually disappear under normal conditions. A bubble over ¼ inch in diameter indicates the capsule is damaged.

CAUTION: certain petroleum products and insect repellant containing DEET will cloud the compass surface and may remove markings.

DIRECTIONS FROM ABOVE

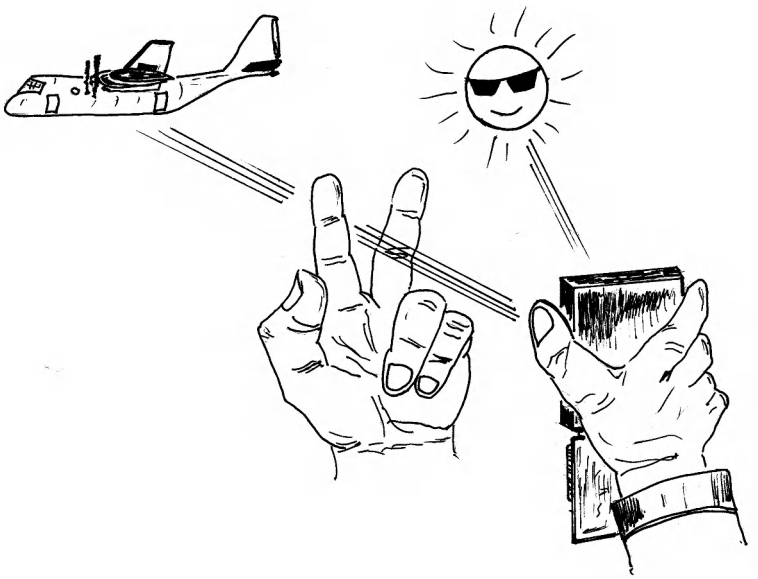
Using a Compass and Radio



Helicopters often guide firefighters and searchers to locations using compass headings. Be sure to note the heading when going out so you know what heading to come back on.

Remember to use the reciprocal or back course.

EMERGENCY SIGNAL



One of the most visible, eye catching signals is a mirror. The light flashes on a sunny day can be seen for 10 miles or more. Use the mirror on your compass to signal for help or to attract attention. It does not take much sunlight to be effective.

If you see an aircraft or target, hold your hand out, making the " peace sign", and use it to sight in your target. Angle the sunlight with the mirror to first shine on your arm or hand. Maneuver the light beam until it shines between your fingers and on to the target.

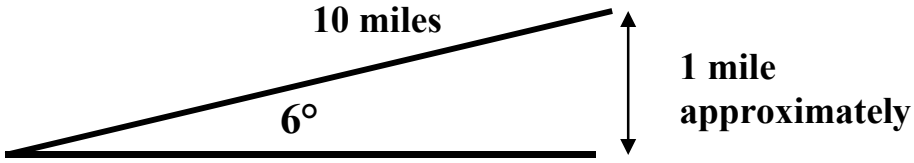
Carefully moving the light beam from one finger to the other, using the mirror, will give a flashing effect.

ACCURACY

How accurate is the magnetic compass?
The basic answer is that it is as accurate as you want it to make it.

In general if you can navigate about the bush within 10° you are doing well. On a lake in a boat - 5° is pretty good. For avid compass hounds being within 1° is often talked about around the campfire. Line cutting and survey work of course takes good instruments, lots of calibrations and a bit of good luck. For the purpose of this manual and general compass use, simply be as accurate as is comfortable. The following chart will give you an idea of accuracy.

1°	At 1 mile out	88 feet	At 10 miles out	920 feet (280 meters)
2°	At 1 mile out	176 feet		
4°	At 1 mile out	352 feet		
5°			At 10 miles out	4,600 feet (1,402 meters)
8°	At 1 mile out	704 feet		
10°			At 10 miles out	9,170 feet (2,795 meters)
15°	At 1 mile out	1,506 feet		

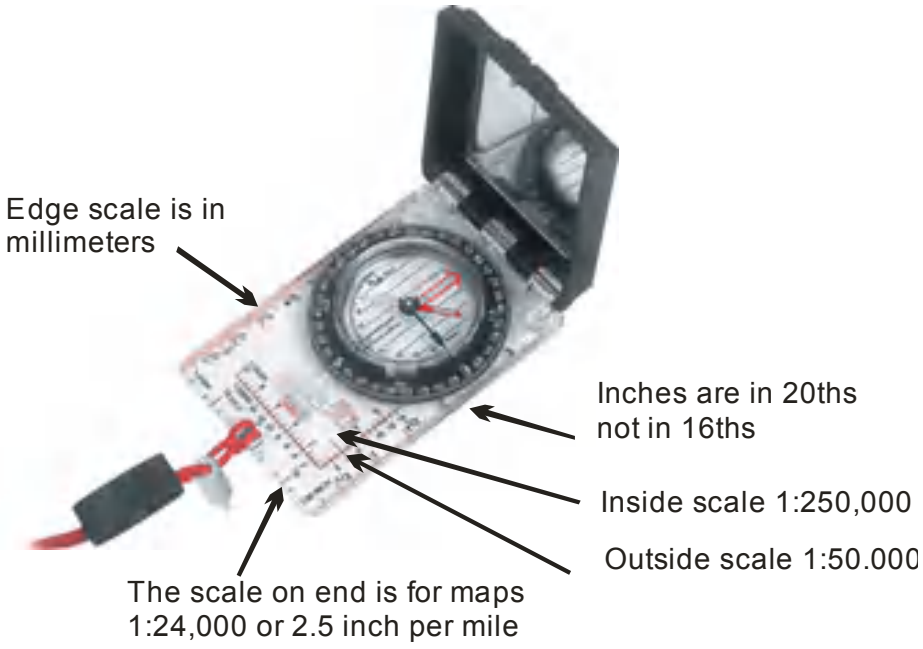


An error of 6° at 10 miles away would put you out approximately 1 mile

MAP SCALES ON A COMPASS

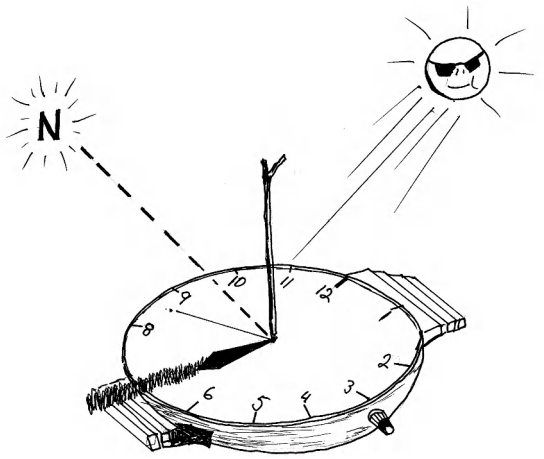
The base plate of the compass may have various map scales on it. This is handy for measuring distances on a map. Be sure you are using the correct scale. Check with the map scale usually found on the bottom of the map sheet.

The Millimeters and Inches scale can be used to measure anything suitable.



Scales printed on a compass base vary widely depending on model

COMPASS CHECK



You may want to check your compass periodically to be certain that it is still capable of pointing to the North Magnetic Pole. Strange things do happen. Compass needles can become "reversed" and indicate in the opposite direction or they may simply loose their magnetic power. Check before you head out on that hike across the Barrens. You may want to check it every few days to be sure. If you know your compass is working ALWAYS TRUST YOUR COMPASS, DO NOT TRUST YOUR INSTINCTS.

Finding North without a compass
Sometime a compass will loose its magnetism or worse yet, may reverse the poles and point in the opposite direction. It is a good idea to check your compass once in a while. To do this –

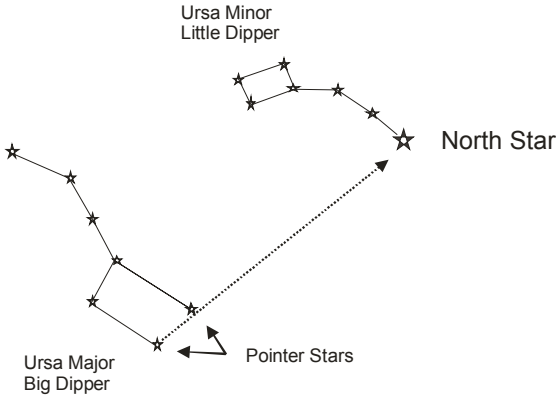
Hold up your wrist watch level.

Now hold a small twig, stick or straw vertically above the center of the watch.

Rotate the watch until the shadow of the twig falls on the hour hand.

True North is half way between the hour hand and 12:00

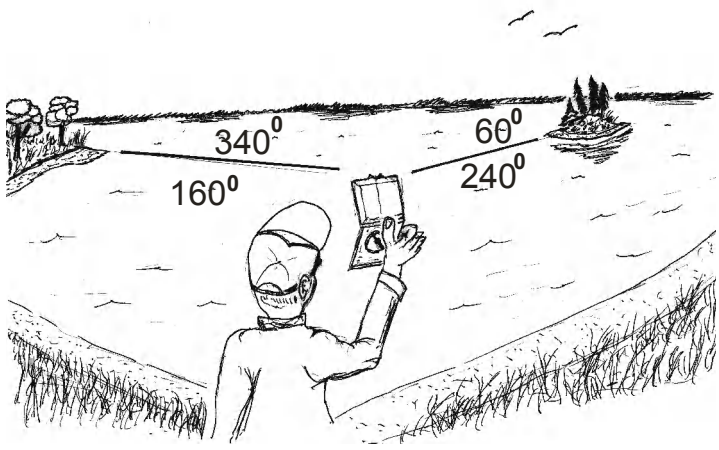
For the purists… because on the west side of Saskatchewan the "Solar Noon" is on average closer to 1:00 o'clock , you will find True North half way between the hour hand and 1:00 o'clock. Solar noon can vary 40 minutes or more depending on the day of the year and location. For practical purposes most people use 12:00



The Pole Star or North Star is True North. It is the last star in the handle of the Little Dipper. It is in a direct line with the two "Pointer Stars" at the front of the Big Dipper. The North Star is the only star in the night sky which appears to stay in one place as the others slowly rotate around it anti-clockwise, once every 24 hours.

Using the North Star is a true bearing, remember to allow for variation if necessary.

METES AND BOUNDS

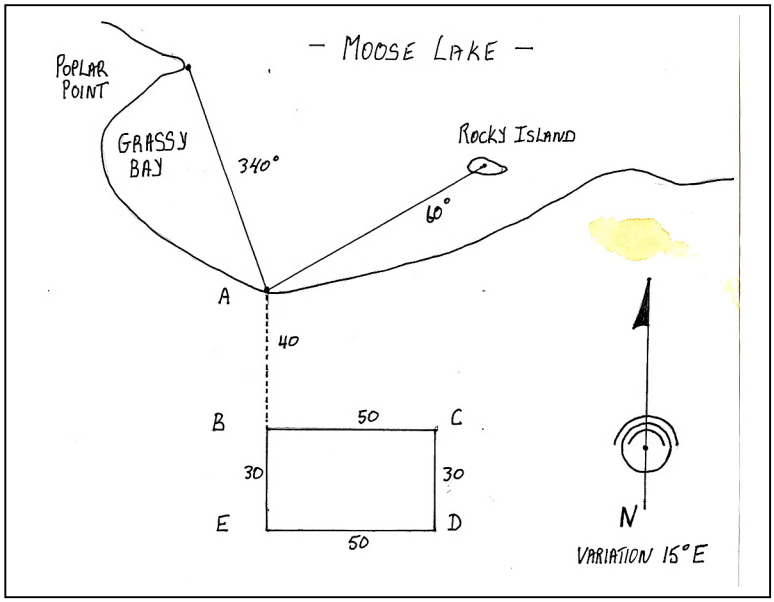


What the terrain looks like,
the bearings and reciprocals

Metes and Bounds is a method of land location or description, by using prominent geographical features or marks and both linear distance measurements and compass headings. Once a starting point is "fixed" then the location and boundaries od a parcel of land (in relation to the starting point) is described.

THE PARCEL OF LAND IS DESCRIBED AS…….At a point of origin on the South shore of Grassy Bay on Moose Lake in Northern Saskatchewan, which lies 160° M * from the farthest end of Poplar Point and intersected by a bearing of 240° M from Rocky Point (Point A); on a bearing of 180° M traverse 40 meters southerly to the point of beginning at the Northwest corner of the parcel; thence 90° M to the East for 50 meters to the North East corner (Point C); thence Southerly 180° M for 30 meters to the South East corner (Point D); thence westerly 270° for 50 meters to the South West corner; thence North 0° for 30 meters to the point of beginning (Point B) , which comprises of 1500 square meters more or less, bounded by the rectangle described herein.

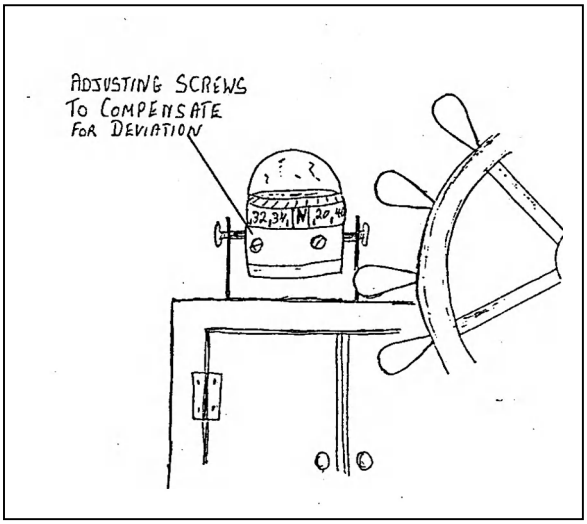
* The compass bearings must indicate whether they are Magnetic or True.



DEVIATION

DEVIATION is often misused to describe **VARIATION** or **DECLINATION**

Deviation is the influence of nearby magnetic fields on a compass needle. It can be caused by ferrous metal objects such as bolts, screws, nails, or even the hull of a boat where a compass is mounted. Electrical fields also cause deviation such as nearby electrical wiring, radio equipment and even the light found in some compasses. To correct for the magnetic influences compensating set screws are built into the compass. They are adjusted to "take out the deviation"



Because not even the compensating set screws can take out all the deviation, in all directions, a " Compass Correction Card" is used to increase accuracy. Periodically a vessel or aircraft has to be "swung" to check to see if the Compass Correction Card is still accurate. "Swinging the Compass" in an aircraft involves parking the plane over a compass rose painted on the airport apron. By comparing the painted headings on the apron to the aircraft compass, corrections can be made. The plane is then "swung" around to each Cardinal Point, checked and a new Compass Correction Card is made up. Often a second set of corrections are added to indicate if the readings were taken with "electrics on" or "electrics off".

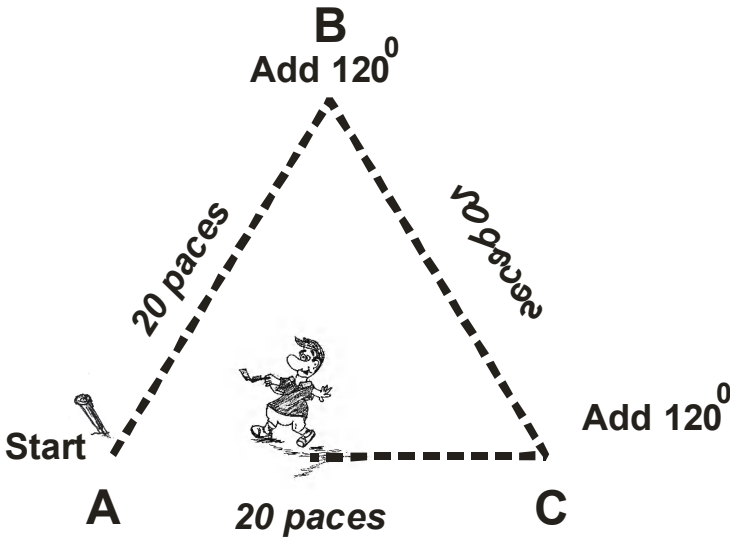
COMPASS CORRECTION CARD

FOR	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
STEER	359°	30°	60°	88°	120°	152°	183°	212°	240°	268°	300°	329°

DEFINTIONS

Azimuth	the angle measured clockwise from north, from 0° to 360°.
Bearings	horizontal angle measured clockwise from North (either Magnetic or True)
Bezel	the ring of degree markings that can be rotated
Boxing the compass	naming all 32 points of a compass in clockwise order
Capsule	a sealed transparent case which houses the compass needle, the azimuth circle and the boxing mark. The capsule may be filled with liquid to dampen needle or card swing.
Cardinal Points	The four points of direction on a compass, North, East,South and West
Circumnavigation	Going around something (an obstacle)
Compass dip	As one nears the North Magnetic Pole, the lines of magnetic force become more vertical. This causes the compass needle to “dip” or point downwards. If the dip is pronounced enough the needle will drag on its bearing or on the inside of the capsule, preventing it from swinging freely. To compensate, hold the compass body at a slight angle. For various parts of the world compass needles are “weighted” by the manufacturer to compensate for dip.
Dead reckoning	Off set course, knowing the distance, navigate to one side so you know which direction to turn when in range. Aiming off.
Field bearing	A compass bearing taken while looking at the landscape and applying it to a map
Fix	The position indicated by the intersection of two or more lines of bearing
Hand rails	Roads, streams, lake shores, line of hills, etc that can be used as a guide in travel, a base line
Inter-cardinal points	Northeast, Southeast, Southwest, Northwest
Isogonic lines	Lines along which variation is all the same degrees
Lubber’s line	A line or mark, on the compass body that points towards the direction of travel. Simple compasses may use North or 0° on the azimuth circle as the lubber’s line. On sighting compasses the sight centre line is the lubber’s line. Index Pointer.
Magnetic bearing	Angle measured between magnetic north, clockwise to a point
Map bearing	Angle measured from True North on a map to another point on the map. Also a bearing taken from a map and applied to the land.
Meridian lines	On a compass they are the same as the orienting lines. On a map they

Practical Exercise 1



A PRACTICAL EXERCISE: Pace out an equilateral triangle and see how close to your start point you can come. This tests your ability for accurate shots and pacing.

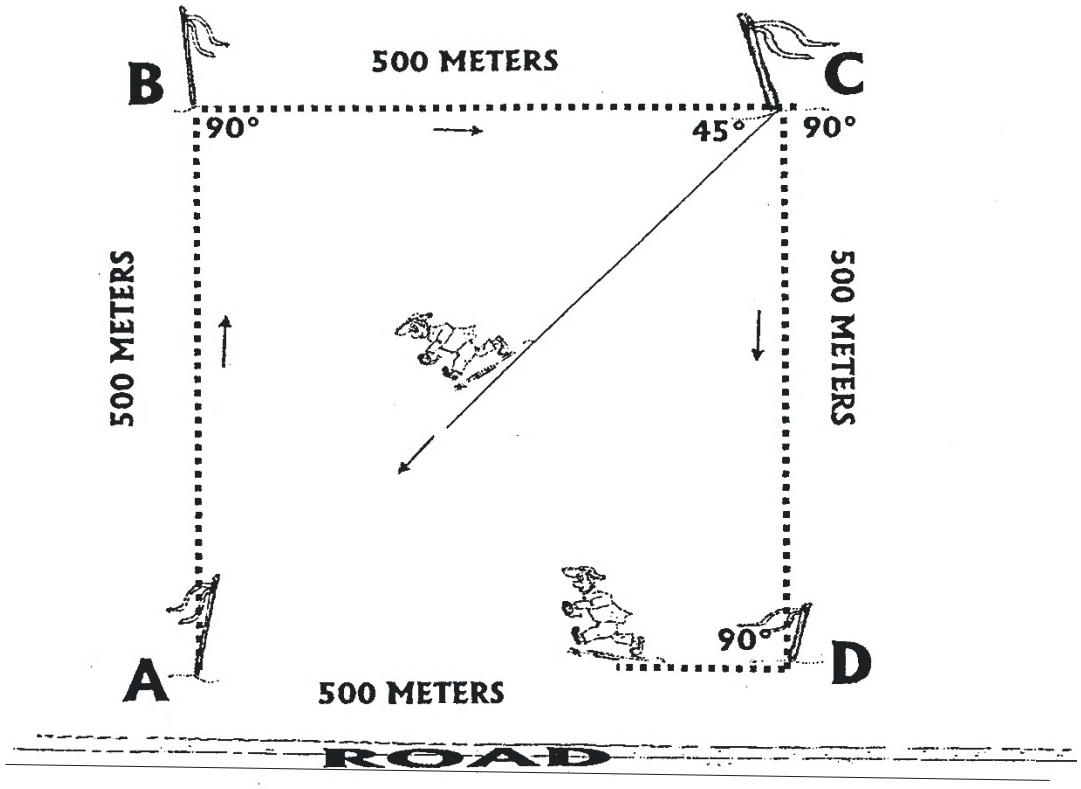
Make a mark on the ground at **point A**. From this starting point select a heading – for example 30°. Take a compass shot, pick out a prominent object, put away the compass and walk **20 even paces** along the compass line and stop. This is **point B.**

Now look at your compass, add 120° to your heading and take another compass shot. (30° + 120° = 150°). Pick out a prominent object, put away your compass and walk towards it. Walk **20 even paces** along the compass line and stop. This is **point C.**

Now look at your compass, add 120° to your heading and take another compass shot. (150° + 120° = 270°). Pick out a prominent object, put away your compass and walk towards it. Back to **point A.** (20 paces)

How close did you come to your starting mark.? If 20 paces is not suitable use and convenient distance.

Practical Exercise 2



PRACTICAL EXERCISE: Pace out a square **500 meters** by **500 meters** (or anything suitable) to see how close to your starting point you can come. An alternate to this, is to start out as a square, but at **point C** head directly back to **point A** to make a **right triangle**. This exercise tests your ability for accurate shots and pacing.

If possible, start out along a road and run a compass line in the shape of a square, each side 500 meters, with the last side along the road. **Flag each corner A, B, C**. Use your own personal pacing to measure 500 meters.

If the alternate is chosen, at **point C** you would have to add **135°** to your heading in order to head directly back to **point C**. The distance should be **707 meters** approximately. (inside angle of 45°, 180° - 45° = 135°)

How close did you come to your starting flag?