EMPLOYING MAP AND COMPASS
Ver. 4.0

By Tom DeLuca, Pack 400

"When you have worn out your shoes, the strength of the shoe leather will have passed into the fiber of your body. I measure your health by the number of shoes, hats, and clothes you have worn out. He is the richest man who pays the largest debt to his shoemaker..." Ralph Waldo Emerson

The purpose of this training: As a result of this course, each participant should be able to determine their own ground location on a Map, and demonstrate Map & Compass techniques.

Needed supplies: Topographical Map of area, Needle Map Compass, Paper, Pencil, and Scientific Calculator.

INTRODUCTION

Everybody who goes out into a wilderness area, especially if they have never been there before, whether just simply fishing, boating, hiking for the day, or actually camping, needs to carry on their person:

Water
Small First Aid Kit (Snake Bite Kit)
Sun-Screen (Sunglasses)
Whistle
Pocket Knife
Waterproof Matches
Space Blanket

and a Map & Compass.

When traveling in wilderness that you have never seen before, a map, without knowing where north is... is just about worthless. How are we going to orient our maps in low visibility rain or fog without a compass? (There are however many Boy Scout ways of finding north as we will see...)

On the other side of the coin, a Compass, all by itself, without a Map, is also totally useless. Sure, we can find north, but what good is that information, if we have no specific destination, or landmark to aim for? Just walking north may send you deeper into the woods. While your are lost, you could use the compass to scout around the area safely. However, if you do not even have a "map" in the mind, the simple idea where you're going, the knowledge of north is not going to be much good.

A Map & Compass work together to form a single Vital Tool, for guiding anyone through the backcountry, through any situation, or weather condition.

The trained Men and Women of our Mountain Search & Rescue Teams are the ones called in from their regular jobs and volunteer to find lost victims. They say that the rescues of literally thousands of hikers, campers, and hunters, which lose their way in our National Wilderness areas every year, could have been avoided if these people had only used a map and compass. They say that many of the people that do carry them, don't even know how to use them properly. A great number of these lost people end up being experienced Outdoorsmen who were to involved with looking around, and just forgot to pay attention to where they were.

In our country, the funds used to mount a rescue operation, is so large, that some counties are just not equipped to meet the financial drain. In parts of the United States, rescued people have been made to pay for their own air-ground search operations.

So far in our local San Bernardino mountains,the cost of mounting a search operation is charged back to the county to which the lost person lives.

Maps are a highly reduced written representation of the ground as seen from the air. They magically allow us to transport a small portion of the world around in our pockets. With all a map's pretty colors, lines, and patterns, it's important to remember that there isn't a single dot, dash, or line drawn on it just to make it more appealing to the eye. Even the single dash/space in the twisting line of a foot trail represents 120 feet.

Take your time. They take some careful field observation, thought, and study, to see all the information they present. Look at as many different maps of the area that you can get your hands on... before you step one foot into wilderness. By the time you find yourself "lost," it maybe already too late to use your map & compass. Fear can set in, and hamper your ability to think properly. At all times, without exception, plot your course, and fix your position with a pencil. Even if you are traveling with very experienced people, don't just blindly follow where they lead. They can become dehydrated, injured, or turned around, and maybe just have not discovered it yet. It may be left up to you to come up with a plan of action. With the solid understand of map & compass given in this course, and a little back country common sense, navigating through any

unfamiliar area should hold no problems for you.

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"Cartography," is the modern science of making maps & charts. The actual name "Chart," comes from the Greek word "Chartos," meaning "Leaf or Sheet of Paper," and is usually a map that is used by sailors, aviators, and astronomers. The name "Map," comes from the Latin word "Mappa," meaning "Napkin or Cloth," and usually refers to a chart of the land.

TYPES OF MAPS.
`Atlas' are a collection of Maps bound into a book.
`City Maps' are called `Planimetric Maps' showing roads and freeways.
`Land Use Maps' are used in agriculture and soil conservation.
`Cadastral Surveys' define boundaries of tracts of land for real estate ownership and tax purposes.
`Soil Maps' are Aerial Maps used for planning highways.
`Population Maps' show where people are concentrated.
`Rainfall Maps' show the annual precipitation.
`Globes' show a planet as a whole in a way that a Map can not.
`Relief Maps' have bumps at the higher elevations.
`Political Maps' show different colors for various countries.
`Forest Service Maps' show basic features, mountains, stream names, and jeep roads but are without contour lines.
`Weather Maps' appear in the daily news paper.
`Wind Charts' show the prevailing wind currents and their names.
`Nautical Charts' show the depth of the ocean floor.
`Aeronautical Charts' are used by aviators.
`Star Charts' show nebulae and constellation locations.
`Mineral Maps' show the kinds of ore in the ground.
`Topographic Maps' show the relief of the landscape as lines.

Just to name a few.

Many maps are dual purpose, as they are overlaid with several types of Map information.

Every Pilot, Sea Captain, or wilderness Backpacker, starts and ends their trek by first defining a course, no matter what method of route finding is used during the trip. Plotting a course in route, always involves dealing with what is presently around you here and now, as well as what is to be coming up in the both the near, and distant future. The outdoor enthuest must at all times, know his position by checking his map & compass frequently. He also needs to be aware of alternate routes, should danger hamper his progress.

It is to your own best interests, and for the good of mankind as a whole, that you come to be comfortable with the world of maps & compass.

TOPOGRAPHIC MAPS.
The Greeks did much in helping to develop the field of geography, and the derived word "Topographic," comes from a combination of 2 Greek words. "Topos," meaning, "Place," and "Graphin," meaning to "Write or Draw." Topographic maps, developed by the United States Department of the Interior Geologic Survey Team (USGS), are what backpackers use most in wilderness travel. This type of map can give the trained eye a very good idea of the lay of the land.

The skills of reading a map, begin with first finding the correct map. The TITLE or name of a map is found in the upper-right, and lower-right corners of a Topo Map. It will be named after the most clearly visible location within it's boundaries. It could be named after a mountain, a town, or even a lake, ect... When the map is folded for storage, this name should be allowed to face out.

The DATE the map was made, is located in the lower-right corner, and it references how far back the map was actually drawn, or at least updated. It is very important to take note of it, because many maps being sold today have not been updated now for over 50 years. This means all the newer changes in the landscape will not have been printed on them. However you can bet that the map was probably correct when it was first surveyed. Examples of some kinds of changes to watch for include:

Completely new trails & new forks in old ones.
Newly built man made features, and the removal of old ones.
A swamp may have been drained, or deepened into a lake.
Lakes can silt up into marsh.
Streams can dry up, or be diverted.
A dirt road may have been made into a highway.
A forest fire may have ravaged the area, and foliage hasn't grown back yet.

So be aware of the revision dates on maps. PURPLE DATES and FEATURES mean that new information, gathered by aircraft or satellite photographs, have been added to the map, but that it has not been re-surveyed in the field yet.

MAP SCALE. Since the 1920's, it has been a practice to subdivide a 360 degree globe, into Degrees, Minutes, and Seconds of Arc. Each Degree is broken down into 60 Minutes, and each Minute is broken down into 60 Seconds, just like a 24 hour clock. A 7-1/2 Minute Map (or 7'30"), covers 7.5/60ths of 1 Degree of land area on the real globe.

A 15 Minute Map covers 15/60ths of 1 Degree of area on the globe. A Four times larger area than the 7'30" maps.

As the Earth turns, it will take the Sun just 7 and a half minutes, or 15 minutes, to sweep over the area covered by these maps.

LONGITUDE, (North/South lines), is also called "Meridian," and starts at 0 degs (The Prime Meridian) at The Greenwich (pronounced "Grennitch") Royal Observatory, near London England, and counts up as it increments west. On the left side of the Map, a typical west longitude on a 7-1/2 Minute Map might read 117 deg 37'30" (read 117 Degrees, 37 Minutes, and 30 Seconds), and on the right, 117 Deg 30'. So by example...

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  117Degs 37' 30"
- 117Degs 30' 00"
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   0 Degs  7' 30"
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That equals 7-1/2 Minutes across.

LATITUDE, (East/West lines), also called "Parallels," starts at 0 Degs at the equator, and becomes 90 degrees at the poles. This means there is only 180 individual degrees from South to North. However, looking at a silhouette of the planet, you would see there is actually 360 degrees in this direction also.

The typical 7-1/2 Minute Map might read 34 Deg 22'30" at the top, and 34 Deg 15' at the bottom. So by example...

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  34Degs 22' 30"
- 34Degs 15' 00"
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   0 Degs 7' 30"
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That's also 7-1/2 Minutes.

So the area covered by a 7-1/2 Minute Map is really 7-1/2 Minutes North Latitude by 7-1/2 Minutes West Longitude. (About 8x8 miles.)

By the same token, the area covered by a 15 Minute Map is really 15 Minutes North Latitude by 15 Minutes West Longitude. (About 16x16 miles.) This is simply what the Maps are called, and how they arrived at that distinction.

If you look at Topo Maps of the U.S. closely, which are also called "Quads" for short, you will notice that the Maps are not perfectly rectangular. In the Northern Hemisphere they are wider at the bottom than they are at the top... Get a ruler out and measure it... Hmmm... Let's see, 7-1/2 Minutes Latitude by 7-1/2 Minutes Longitude... Sounds like a perfect square... So why AREN'T they square? Well these Maps are not simply Maps of a region like a Car Map is. These are actually "Area Maps" that show a "Quadrangle of land" as based on USGS Land Surveys, which are in turn based on Latitude & Longitude lines. They are called "Polyconic Projections,"

meaning that they are drawn to have every parallel line (Latitude) equal to those distances on the globe, sort of what you would really see looking down from space. The Longitude lines as they near the poles, get closer together, and you would expect a "Polyconic" Map to also reflect this. A Map of the equator region will be nearly a perfect square. But at Latitudes above 45 Degs, Topo Maps grow taller and narrower. Maps of the far northern edges of Alaska are nearly triangular in shape. The 1:24,000 Scale series Topo Maps will cover 68 square miles in southern Texas, but only 49 square miles along the Canadian Border.

In more than 50% of America, Latitude & Longitude is also broken down into RANGES, TOWNSHIPS, and SECTIONS, as is seen on all western QUADRANGLE Maps produced by the USGS. This information is also conveniently found on western FOREST SERVICE MAPS, and we will be covering this aspect further in a moment.

The SCALE of a map is also explained as a ratio between the distances on the map, as compared to the real distances on the landscape. It is expressed on a Topo Map as a fraction such as 1:1,000,000 which means that 1 UNIT of distance on the Map, equals 1,000,000 UNITS on the earth. If, for example, 1 inch on the map, equals 1,000,000 inches on the landscape, the 1 inch would equal about 15.7 miles of landscape.

The most useful maps for wilderness travel are by far the 7-1/2 Minute USGS Topo Maps, as the 15 minute maps are being phased out. The 15 Minute Map covers almost four times more area than a 7-1/2 Minute Map does. But the 7-1/2 Minute Map shows much greater detail in the landscape.

A 7.5 Minute Map is said to have a "larger scale" because it has a ratio closer to 1:1. Features of the land on the 7.5 Minute Map (1:24,000), look bigger, than they do on a 15 Minute Map (1:62,000). Small scale maps cover larger areas. A globe is a "small scale" map.

Distances on most maps are also represented by a BAR SCALE. It is found at the bottom-middle of the Topo Map, or in the "Legends" of most other maps. It can convert inches to miles, feet, and kilometers, and the map can be easily Xeroxed, educed or blown up, with out any loss of scale.

A 15 Minute Map typically has a scale of 1:62,500, meaning 1 inch equals about 1 mile (5280 feet * 12 inches = 63,360 inches in a mile). The Map covers 14.5x17 miles (not square is it?), and the "Contour Intervals" are 50 feet apart.

A 7.5 Minute Map typically has a scale of 1:24,000, where 1 inch equals about 2,000 feet (.378 miles). The Map covers 7x8.5 miles, and the "Contour Intervals" are 40 feet apart.

Other common USGS Map Scales Include...

7.5 Minute Maps have a Scale of 1:24,000, where 1 inch = 2,000 feet, and covers 49 sq. mi. along the 48 parallel, and 71 sq. mi. in Texas.

7.5x15 Minute Maps have a Scale of 1:25,000, where 1 inch = 2083 feet, and covers 100 to 140 sq. mi.

15 Minute Maps have a Scale of 1:62,500, where 1 inch = 1 mile, and covers 197 to 282 sq. mi.

30x60 Minute Maps have a Scale of 1:100,000, where 1 inch = 1.6 miles, and covers 1578 to 2167 sq. mi.

1x2 Degree Maps have a Scale of 1:250,000, where 1 inch = 4 miles, and covers 4580 to 8669 sq. mi.

Around the border of the Topo Map, you will find 8 NAMES OF OTHER MAPS. These are the names of other Topo Maps that match up, and belong next to this current Map. If your trail dips off the map momentarily, and returns to the map, be sure to pick up the neighboring map also. The little off map hike may twist unexpectedly and take you miles out of your way. You may not know this until it's too late, when the sun is setting.

GRID LINES. Look around the edge of the Topo Map for blue numbered indexes, or TICK MARKS. These are accompanied with numbers like 3801, or 445, having 2 different sized characters representing the same number. They are spaced at a distance of 1 Kilometer apart, and are also called "Klicks," short for Kilometers.

This Grid System is borrowed from another type of map called the 1,000-Meter Universal Transverse Mercator Map, or UTM Grid for short. You will find this reference in the lower-left corner of the Topo. A "Mercator Projection" was named after Gerhardus Mercator (Juh-rahr'-duhs Mur-kay'-tur, 1512-1594), a Flemish Cartographer, who first developed it in 1569. It is the flat map of the world, found in every school class room, which badly distorts Greenland, Alaska, and Australia. It is still used on just about every modern boat and aircraft that crosses the pacific and Atlantic oceans. Back in the days of Marco Polo, Magellen, Columbus, and Sir Francis Drake, it was the only map they had. It is by far the most widely used Nautical Chart of all time. The Military is now using the Mercator Grid System as it's Standard Coordinate System, and since it is already printed on our maps through out the world, it provides us

Another way to locate exact points on the map. The calculation of Latitude & Longitude into Degrees, Minutes, and Seconds, is much harder to do than using the UTM Grid, and this method has become very popular in Great Britain, and with our own Search & Rescue Teams here in the United States. The Forest Service, being a "Land Management" organization, still uses the Quadrangle coordinate system however.

GRID COORDINATES are places where the Horizontal and Vertical Grid lines cross.

Between each Tick Mark, each Kilometer is subdivided into 10 more subsections, having 100 meters each. So a "Grid coordinate" number will have the main coordinate, of say 57 kilometers from a Latitude or Longitude line, and will also state the number of 10th's within that kilometer. Say 57.3 for example, so your coordinate would be 573. If you get within 100 meters from someone on the ground, you're close enough to yell for them.

Look for the "Hard Corner" of your 7.5 Topo map. This is the corner where both the latitude and longitude lines are marked as ending in 30" seconds. This would be the center of a 15 minute map of the same area. There is only one Hard Corner per 7.5 minute map. It can be 1 of any of the four, depending on the map section you have. It is an important corner. There you will see that the Grid Tick Marks are really way up in the thousands. The map will read 466000meters E longitude x 3775000meters N latitude, and they indicate the number of Meters from a major Meridian or Parallel Line. Only the larger BOLD numbers on the map are used for giving Grid Coordinates, and the smaller numbers are left out completely, so the NAME of the correct map becomes part of the coordinate also.

A typical Grid Coordinate location would look like...

San Bernardino, 15 minute Quadrangle, UTM 326-301

Meaning the location is on the San Bernardino map, at West Longitude Grid Tick 32 & 6/10ths Kilometers by North Latitude Grid Tick 30 & 1/10ths Kilometers. The order of the 2 numbers is always "Along the corridor and up (or down) the stairs," (Long then Lat).

The DECLINATION CHART is located at the bottom of the Topo Map. It shows the different angles between TRUE NORTH, MAGNETIC NORTH, and GRID NORTH. In map making, it is standard to place True North at the top of the Map. But don't assume this. Look on the map, as there will be an arrow to point to north. Grid North as an example, is not exactly a MERIDIAN LINE, meaning that it does not exactly point to the North Pole. It's deviation from True North will always be shown on the Declination Chart. This chart is a very important part of the Map for anyone using a Map & Compass. You will be getting to know it very well.

TRUE NORTH is a directional line between any position on earth, to the True North Pole. All lines of Longitude are True North

lines, and are also called `Meridian Lines.' True North is usually symbolized by an ARROW WITH A STAR on a Topo Map.

MAGNETIC NORTH is the direction to the Magnetic North Pole. It is actually the southern pole of the earth's central magnet, as is shown by the north seeking needle of a Compass. (Like magnetic poles repel, while unlike poles attract.) Magnetic North is usually symbolized be HALF AN ARROWHEAD on a Topo Map.

GRID NORTH is the north that was established by the vertical grid lines during the Map making process. Grid north is usually symbolized by the letters GN or the letter Y on a Topo Map.

CONTOUR LINES on a Topo Map are brown. They join all heights of the same altitude together. The difference between 1 contour line and the next is called the CONTOUR INTERVAL, and this value is located at the bottom-center of the Topo Map, under the BAR SCALE.

Every 5th Contour Line is a darker brown line called the INDEX CONTOUR, and it has the elevation printed on it. Each Contour Interval may equal 200 (or 250) feet between dark lines.

In addition, there are brown DASHED CONTOUR LINES in placed between the normal Contour Lines in very flat areas. These are called CARRYING CONTOUR LINES, and they represent elevations between very widely spaced Contour Lines. For example, in a Desert area where the land may gain or lose 50 feet in a mile, and the Contour Interval of the map were 40 feet, the Carrying Contour Lines would represent 20 foot indexing.

When Contour lines are widely spaced, you can expect to find a gentle slope. When they are bunched really close together, you can expect there to be a cliff. As contour lines cross a riverbed they look like a "V" shape pointing up stream. When they go around the spur of a mountain they look more "U" shaped and point down the hill. Map reading is skill you'll have to develop. Only by practicing it, will you be able to see the shape of the landscape, in your minds eye.

TRIGONOMETRIC SURVEY POINTS, or STATIONS, are very accurately surveyed places, marked on the Map. They can help give a map reader an accurate idea of the land's actual relief. There are "Vertical Controls," and "Horizontal Controls."

A permanent "Bench Mark" (BM), is a small 6X6 inch concrete pillar with a brass USGS disk marker called a "tablet," physically placed in the ground, usually at mountain summits, but also in the flat areas around the city. These are called Monuments or Stations. On the BM's face is inscribed the exact elevation above sea level, and the latitude and longitude of the marker. They can be a Vertical Control, a Horizontal Control, or both.

These BM Monuments are used as the corners of much larger triangles. The Geological Survey Department them for calculating

altitudes and distances around the local area, using angular measurement (Trigonometry & Geometry), for the exact placement of buildings and bridges, to follow design engineering diagrams.

There are many kinds of surveys. Surveys of water are called Hydrographic Surveys. Surveys for roads or pipelines are Route Surveys. Surveys of the land for property lines are Cadastral Surveys. Surveys that set the wooden steaks in the ground at a construction sites are Construction Surveys used in building bridges, mining tunnels, and buildings, don't remove them from a construction site.

VERTICAL CONTROLS, can be found anywhere, in walls, gate posts, sides of buildings, sides of trees. They show the height above average sea level which has been figured out very accurately. Permeant BM Monuments are marked on the map as "BM x with elevation." Recoverable markers (typically red plastic surveyors tape nailed in place) are marked on the map as "x with elevation."

HORIZONTAL CONTROLS, usually appear only on maps along roads, near sea level, and in deserts, to better aid the map reader on very large flat areas of land, where the contour lines are naturally widely spaced. They can be monuments, recoverable, or not marked on the ground at all. They are however always marked on the map with an "Triangle with elevation," or "BM Triangle with elevation" for permeant Monument markers.

QUADRANGLE markings, also called "Cadastral (ke-das'-tral) Coordinates" or "Legal Descriptions," show up across the face of the Topo Map as very light red lines and numbers. The squares are in groups of 36 blocks, called Townships, and are repeated over and over again across the face of the map, and is super imposed over the map's regular Contour Line data. These are PUBLIC LAND SURVEY (USPLS) area measurements, and are public records used to record the value, extent, and ownership of land, as a basis for taxation. The location of your map's QUADRANGLE within the state, is located at the bottom of the Topo Map.

In 1785, the system called the "Land Ordinance" was created. Thomas Jefferson saw that the migration west, needed some orderly way to transfer blocks of homestead land to the settlers, without leaving unused slivers of land left over.

Each red outlined box, with it's associated number, is 1 SECTION OF LAND, and it equals 1 square mile (or 640 acres). They do not show up over some Federally Owned lands, Indian Reservation property, Hawaii, Kentucky, Maine, Texas, Vermont, West Virginia, or District of Columbia, or the 13 original states.

Each area of 6 x 6 `Sections Of Land' is equal to 36 square miles, and is called 1 TOWNSHIP.

A RANGE is a vertical row of Townships, numbered East and West from a survey Base Line, and is numbered along both the top and bottom margins of the Topo, and the Forest Service Maps.

BASE LINES are not true Longitude or Latitude Lines, and have nothing to do with them at all. In many places Base Lines do not even line up with true north. They tend to be North/South, or East/West bearings to the highest spots in the area. In the different states, or even different parts of the same state, the centers from which surveyors make Base Lines from, can be different. The Base Line centers in the past have been anything from mountain peaks, to city capitol buildings. Between the Base Lines, where the Ranges, Townships, and Sections have fanned out and now meet, there is usually an uneven meshing of the Township lines at state lines, rivers, or at other borders.

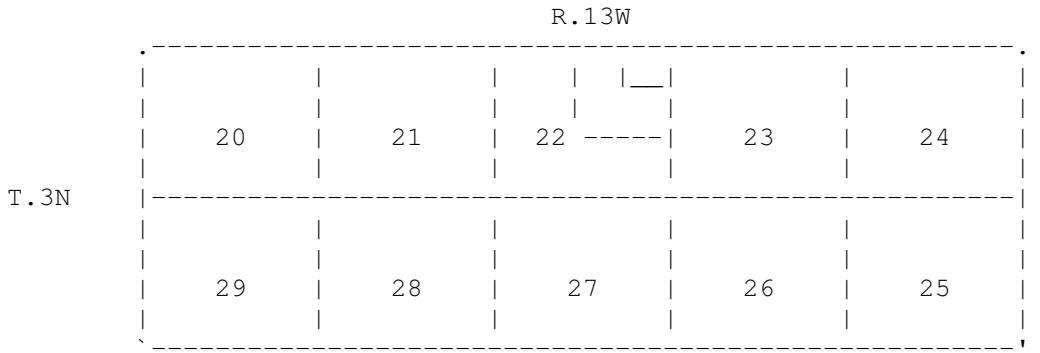
This is a purely Unites States System, and not a Global system as the Mercator Grid is.

Ranges are numbered along the top and bottom margins of a map. Townships are numbered along the left and right margins. This yet another way to find a Map coordinate location. A typical coordinate will look like...

Angeles Forest R.13W, T.3N, S.22, NE-1/4, NE-1/4.

This translates to:
On the Angeles Forest map,
Range 13 West of the Survey Base Line,
Township 3 North of the Survey Base line,
Section Of Land # 22,
Northeast 1/4 corner of that section,
and the Northeast 1/4 corner, of that corner, of that Section (ie. 1/16th of that Section #22, = 40 acres).

Many "Rock Hounds" (People that collect rocks for a hobby,) find their mineral locations using this system.



Grid Coordinates vs. Quadrangles.
Ranges, Townships, and Sections MATCH EXACTLY the Forest Service Maps covering the same area. Every Ranger has access to this information, on both their standard Maps, and on their computer software. To the leader of a lost or injured person, over the phone, it is the most convenient way to tell the FOREST SERVICE where to start looking.

For Sheriff Mountain Search & Rescue Teams, Grid Coordinates should be used, as the Quadrangles are not used at all.

When the "runners" are on the phone, Rescue is going to ask for some coordinates. Figure them out before hand, and write either the Quad range/township/section, or Grid Coordinates on the back of the map.

Neither service uses Latitude & Longitude for map coordinates.

On your part, it takes several calculations to get down to Degrees, Minutes, and Seconds, and mistakes can be hazardous to the victim. Plus, Dispatch has to convert Latitude and Longitude back over to Quadrangle or Grid, before he can quickly make a computer print out of that specific area to give to the helicopter pilot.

Emergency Procedures... To be put on back of extra map to be given to person running for help. (Put info on a card and keep in first aid kit along with numbers of your local Sheriff's Department.

- Date/Time of accident...
- Subject's (person) name... Sex...
- Description of injury or illness...
- Exact location of evacuee... Marked with a X on the map to be given to rescuers.
- What is wrong... give the details is victim pale/flush, what is pulse rate, respiration rate, is he conscious or not.
- Number of members in your party...
- Party location and condition...
- Type of evacuation support requested, when, and where...
- Needed extra medical equipment or personnel requested..
- Details of evacuation plan. Course chosen by the main evacuation party, including litter route, helicopter landing site, with dates for each day of the evacuation...
- Address ALL compass bearings as either Magnetic North (MN), or True North (TN). (234 Deg TN or 90 Deg MN)...
- Site for runners and main party to reconvene and dates...
- Details of contingency routes...
- Signature of group leader and other witnesses...

The real advantage to knowing about Quadrangle sections, is that the Map is already marked off in mile squares when you buy it. The trained eye, at a quick glance, can immediately tell about how many miles to go to reach the destination without the need to measure.

THE 7 COLORS OF A TOPO MAP

BLACK - Cultural Man Made Objects - such as Campgrounds, Bench Marks, Roads, Buildings, Water Tanks, Schools, Churches, Mines, Dams, Railroad Tracks, Power Lines, Trails, Names, Boundaries as County, State, Forest Service District, or National Forest.

BLUE - Hydrographic Features (water) - Names, Oceans, Lakes, Glaciers, Swamps, Springs, Dry Lakes, Seasonal Streams.

BROWN - Contour Lines, Carry Contour Lines, Depressions, Peak Elevations, Earth Levees, Sand Wash, Gravel Morain.

GREEN - Vegetation - Mangroves, Solid For Woods, dotted pattern for chaparral, Orchards, Vineyards, or Woodland Swamp.

RED - Primary Highways, Roads Under Construction, Bridges, Land Survey Corners, lines.

WHITE - No Vegetation - Surface Grassy, Sandy, Rocky.

PURPLE - Features Added From Aerial Photographic Information During Map Revision, Not Yet Checked In The Field.

TOPO SYMBOLS.

Symbols can either be directly representational, or an icon, and are printed in colors consistent with what they mean. A copy of the Department Of The Interior's pamphlet "Topographic Map Symbols" is free at any location that sells Topo Maps (3$), and it describes all the symbols found on Topo Maps. The Boy Scout Handbook, and the Fieldbook, also covers symbols.

Topo Maps also show Man Made Features. But beware, man made things can appear and disappear over night. So don't place too much reliance on them. Learn to read the shape of the land, as the land surface will almost never change.

HOW TO FOLD A TOPO MAP.

Topo maps are not folded when you buy them. They usually get rolled up instead. On the trail, it is normal to fold the Map "anyway you have to" in order to see on it, the area you are walking in.

However at home, for the ease of locating the correct
Map from a larger pile, it is best to fold a Topo Map like a "W".

That is first, in the vertical direction fold it face to face, folding the Map in half. Then fold back the outer edges so that the Map's name shows in the upper-right corner. Then in the horizontal direction, fold the Map in half, and then fold the upper and lower portions back, so that the name still shows. In this way you will be able to locate a specific Map without having to open every one to see the name each time.

HOW TO PROTECT MAP FROM THE WEATHER.
If you carry a plane paper Map into the wilderness, you will need to protect it against the elements. Against over folding, against jelly & peanut butter sandwiches, and against it just plain wearing out. If it gets rained on, it could tear, and be next to useless in helping you find your way. There are clear plastic Zip Lock Map Pockets, sold on the market, that let you refold the Map, and stuff it inside so that the area you will be walking shows through. The 2 gallon 'Zip-Loc Freezer Bags` can also be used. There is also a product called 'Aqua Map Seal` for permeant water treatment, that also prevents the map from fraying, as it allows you to fold and unfold indefinitely. A single 8 fluid ounce bottle treats about 15 Maps, ($6). 'Thompson's Water` Seal is another method. And a product called 'Clear Seal` for basements is another product to try.

"I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived..." Thoreau.

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* Magnetic Compass *
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HISTORY OF THE COMPASS.
All official badges of the Boy Scouts of America, are issued by the National Council in Irving Texas, under the Authority of Charter of the US Congress. They can only be worn by BSA members.

They are protected, (as is the uniform,) by U.S. Letters Patent 41512 and 41532, and anyone infringing upon them is open to prosecution. The Boy Scouts of America reserves the right to recall for cause, at any time, any badge awarded.

While the Scouting Symbol itself may look like the French "Fleur-de-lis," it was really the True North symbol as taken from the Mariner's Compass face. The Compass was, and still is, an extremely vital tool for navigation.

It has been said that the Chinese knew about the "magical" magnetic properties of the iron mineral ore called lodestone, way back as early as 2634 B.C, over 4,500 years ago.

At that time, they had no idea that while the iron ore was still hot volcanic magma, it's atoms had aligned with the earth's magnetic field, and as it cooled back to rock, it became magnetized.

The ancient Greeks also knew about the weak attraction lodestone had to tin, but the compass's first actual use to get bearings at sea, is placed closer to around 300 A.D., about 1,500 years ago. Chinese sailors were reported to be using it around 1100 A.D. Arabian merchants had started using it by 1220 A.D., and the Scandinavian Vikings by 1250 A.D.. Marco Polo brought Europe's first compass back from the Chinese city of Cathay at the close of the 1200's, around the time of Robin Hood.

In the early days of the compass, it was only a small piece of rock ore, strapped to a small floating piece of wood. It could even be hung by a thread.

The things that the early navigators enjoyed most about the magnetic Compass, was that it was very easy to use. It made steering a ship much more accurate. And it could even be used when the skies were cloudy, when the more accurate method of navigating by the stars was not possible.

In all the past centuries of adventure, when men of courage sailed strange & dangerous seas, and blazed trails across wild unsettled continents, the direction of North was their one and only fixed point on the globe. This 3 pointed sign of the compass, came to stand for the North with the Explorers, Pioneers, Trappers, Woodsman, and Army Scouts. It became their emblem, and has only been slightly changed as centuries passed by.

Today, this same TRUE NORTH symbol has become Scouting youth's fixed point. It guides Scouts of courage, of all ages, through the unsettled times of youth, across strange and dangerous situations, and helps the Scout blaze new Morally Straight trails to freedom, and Truth.

POINTS OF THE COMPASS.
Before the Magnetic Compass was discovered, early map makers would draw a small 16 pointed circle on the map, and place an "N" to point to North. These were the 16 Cardinal Points from which the winds were thought to blow. This drawing was called a "Wind Rose." When the magnetic compass came along, it was naturally just usually set on top of the Wind Rose pattern in order to help face the sea chart in the proper direction. The wind rose started to become known as a COMPASS ROSE. (Today it also called an AZIMUTH RING, or GRADUATED DIAL.)

Since the 1100's, compass bearings have been split into...

N,NNE,NE,ENE,E,ESE,SE,SSE,S,SSW,SW,WSW,W,WNW,NW,NNW,N

This was all the pinpoint accuracy an old Mariner's Compass had to offer, and by todays standards, it was not a very

accurate. However as global spherical mathematics improved, it became more customary to give bearings in units of "Degrees" from Geographic North. In the 1920's, it became an accepted world wide practice to indicate direction, called HEADING, AZIMUTH or BEARING, by a single number, (0-360,) representing degrees of a circle, called "Arc," as measured clockwise from True North.

The development of the compass instrument itself represents scientific achievement, however the actual use of this instrument is more of an art form. Once someone finds a method that works for them, I have found it easier to get someone to change their religion, than to change the way they use a Map & compass.

The Compass is not by any means a complex instrument. Almost every backpacker carries one, and it is very surprising just how few of them are really able to operate it in all, or even most of it's many uses. With a positive attitude, and a determined will to understand, ANYONE from 9 to 90, is able to learn compass operation with just some practice, and understanding a few simple principles. If you are going to carry one, you should at all times (a.) be certain how to work it, and (b.) unless you have proof that it is malfunctioning, TRUST IT! Never look at using a Compass as something hard to do. It's really easy!

TYPES OF COMPASSES.

The FIXED DIAL COMPASS is the typical cheep aluminum .25 cent gum ball machine, or plastic "Zipper-Pull" type compass (6$). Some at first glance even somewhat resemble an orienteering compass. These have a "Fixed Compass Rose" that does not move, that is printed on paper, stuck under the Needle Pivot, or melted into the outside plastic housing. They may or may not be filled with liquid. They are marginally better to use than figuring tree ring growth (NNE), or looking at lichens on rocks (South), but not as good as sighting on Polaris (True North), or using the sun/stick method (True North).

However they do not have allot of different uses. They are not very versatile, because they can not work as a "Pelorus," (a navigation protractor). However, having a Scout carrying one in his survival "10 Essentials Pack" may still be an excellent idea as a back up. (Play around with magnetizing your 10 Ess. sewing needle at home, and floating it on some toilette paper as a backup compass.)

The FLOATING DIAL or CARD COMPASS is the type most found on board boats and in some cars under the front rear-mirror. There are even floating ball key-chain compasses. This type is usually mounted, or gimbaled, to pitch and roll freely, so that ocean swells will not effect it's levelness with the horizon. They are usually sealed inside a liquid filled chamber, so it can spin freely. Old ship's compasses used gin to dampen the compass disk, today Mineral Oil is common. Many offer a setting screw to compensate for metal vehicle dashboards around them, and thus Zero them to Magnetic North. These compasses are read from behind, along an indexing mark or

line, as you are facing in the DIRECTION OF TRAVEL. In order to take a bearing on a lighthouse, the whole vehicle must be turned around and pointed at it. Thus a compass mounted in a vehicle is not as convenient as others we will mention.

The LENSATIC, or PRISMATIC COMPASS is a military type, folding Compass. They usually have an aluminum housing, a sighting wire, and an eye piece, usually made of glass, to view the Compass Rose when a bearing is being taken. Most of the time they employ a "Card" type compass Dial, and this makes for single handed operation. (Any magnetic "needle" type, always requires 2 hands.) The Bezel Ring, attached to the glass face, will click as it turns the Indexing Mark. Each click equals 3 degrees, for reading directions in the dark. A direction of "12 clicks" (from north), equals 36 degrees, or 50 clicks, equals 150 degrees. The Bezel Ring Indexing Mark can be "set," and this becomes your Bearing. A thumb loop helps to aim the compass properly at the end of the operators arm. Some are housed in a "Pill Box" case, and others many have a ruled straight edge along their side. The sighting device, and the Card Dial, together form a "Pelorus" protractor necessary for getting or "shooting" a bearing. They are very ruggedly constructed, and work very well for backcountry navigation.

Any Magnetic "Card" type compass, by it's very nature of operation, is a "Magnetic North" type navigating device. They do not lend themselves to the "True North" methods that a magnetic "needle" type compass will. Their operation is different, don't confuse yourself by attempting to learn BOTH at the same time.

The ORIENTEERING MAP COMPASS is a Swiss design, first developed back in the 1930's. They have a flat Base Plate, and a twistable Compass Housing. These together form a "Pelorus" protractor necessary for plotting a heading.

On the Braun (tm.) compass, the whole Needle Housing moves to compensate for Declination, and is designed to be a "Magnetic North" type device. The Silva Ranger (tm.) uses an adjustment screw that moves only the internal Orienting Arrow, and leaves the Orienteering Lines alone, and is both a "True North" and a "Magnetic North" device. These compasses usually have ruled inch and millimeter scales on their Base Plate.

On the Base Plate itself is the "Direction of Travel Arrow," and this can be "set" to the Azimuth Compass dial, and this becomes your BEARING.

They have Mineral Oil filled Needle Housings, with steel needles that pivot on a sapphire bearing. Do not leave a compass in the sun. The oil vial will heat up and expand the plastic, giving the needle room to either fall off the pivot, or even blow the face off the Needle Housing. At higher altitudes, an air bubble can form in the Needle Housing, but upon returning to lower elevations the bubble will again dissipate back into the oil. This is normal, and not a problem unless a bubble larger

than 1/4 inch forms, and this should be suspected as being a leak in the Housing. A large air bubble can grab the needle and keep it from pointing to Magnetic North.

Both the Lenstatic, and the Orienteering compasses are very good pieces of equipment. However it is the considered opinion of BSA, that the Orienteering Compass is the most flexible type of compass for the recreational navigation in the wilderness.

With this type of Compass, it is possible to determine a Bearing from a Map (True North), without always needing to stop and turn the Map North. Nor is absolutely necessary to draw Magnetic Declination Lines across the face of every map you own.

Wait a minute! Did he say that?... Yep! Using an orienteering compass, you do not need to orient your map, or even draw lines on it. The compass does all this work for you, automatically, as we will see...

Orienteering Compasses may look like a light weight toy, but make no mistake, they are a precision piece of gear. Though they are a durable and rugged apparatus, it should be due the same respect given any fine instrument. Take care not to throw, or drop it, or carelessly let it bang around. They are wonderful scientific tools, yet so simple that an 8 year old can learn how to use it.

WHAT IS A GOOD BASIC ORIENTEERING COMPASS.

[] It will have a Steel Magnetic Needle painted Red for North, that glows in the dark.

[] It will have a Sapphire Needle Bearing that eliminates errors caused by friction of the pivot.

[] It should have a sealed, liquid filled, needle housing, to dampen the swing of the needle in under 4 seconds.

[] It will have an easy to grip rotating Graduated Dial, marked in at least 5 degree or 2 degree increments, from 0 to 360 degrees.

[] It should have a see-through Base Plate with a DIRECTION OF TRAVEL ARROW on it for sighting along bearings.

[] It will have an ORIENTING ARROW under the needle for orienting to declination.

[] It should have ORIENTING MERIDIAN LINES under the Compass Needle, for orienting to True North or Magnetic North "Meridian Lines" on the Map.

[] A ruled straight edge on the flat BASE PLATE to convert inches

into miles on a standard Topo Map, Millimeter, and Inch scales.

[] Lanyard for carrying around on neck.

Other conveniences include...

[] A Sighting Mirror, with a Sighting Line, for viewing both the distant landmark, and the Compass Rose bearing numbers. It is used to get a very accurate reading. (Is also good for shaving and signal aircraft rescuers.)

[] Built in magnifying lens to see tiny Map names, and altitudes.

[] Inclinometer or Clinometer to measure the steepness of trails, to shoot angles to distant peaks and help locate your position.

[] The more expensive Compasses, have an Adjustable Declination Set Screw. This moves the Orienteering Arrow inside the Needle Housing. Once set, it takes care of all mathematic conversions for declination, between Field Bearings and Map Bearings, automatically. (This is the same as placing a narrow piece of tape on the Compass housing to be discussed later. This IS the "True North Method.")

[] Some have an Adjustable Needle Housing that twists and can be reset within the Compass Rose to compensate for declination (Braun).

Every one in the wilderness should have a Map & Compass and know exactly how to use it.

DECLINATION.
The magnetic field of the Van Allen Belt, which surrounds the Earth, is not easy to understand. For one thing it does not run directly through the Earth's center of gravity. It is off-set by several thousand miles away from the center of spin as it runs under the pacific ocean to the southern hemisphere. This causes a different amount of "dip" to be measured along the same latitude through out the world.

For another thing, the Equator, is the only place on the planet where the magnetic lines of force are completely parallel to the ground. Every where else on the planet, the magnetic field points down into the Earth at an increasingly steep angle as we move towards the poles. This vertical angle component, between the magnetic lines of force, and the flat ground, is called "Magnetic Inclination" or "Dip."

At latitudes greater than 65 degrees North, the horizontal magnetic component of the Earth's field, needed to deflect a compass, becomes too weak and erratic for finding directions. Shipboard navigators are required to use non-magnetic gyro compasses (spinning at 26,000 revolutions per minute), Lorans, Omegas, or Celestial Navigation (star charts & Sextant) to triangulate their positions.

(A Loran is a radio that picks up transmitted timing signals. It measures the intervals between 2 incoming signals, and shows the distance to the beacon stations. Omegas use frequency phase shift much the same way as Loran uses time delay, for locating a ships position along well defined shipping lanes.)

The increasing strength, of the vertical magnetic lines of force, as they converge into the ground at the poles, are many times stronger than they are at any other place on the planet.

Compasses are manufactured with the proper amount of counter weighting, and the proper amount of magnetizing lines permeating the needle. They are made in close proximity to the actual angles of force it will encounter in a specific continental location in the world.

As an example, as a "made for U.S." compass, nears the pole region, the magnetic needle will increasingly begin to point into the earth. You'll have to hold the compass housing unevenly to get any kind of reading at all. All the needle wants to do is point into the ground, and not to the horizon. Maybe a Needle with a weaker magnetic field, or counter weighted differently may help. However there are places on the globe where it is impossible to get any reading at all, with any kind of magnetic compass, due to this phenomenon of "dip."

So if you are going to Alaska, Finland, or Australia, be sure to pick up a Compass made for that area, as your made for U.S. Compass will prove to be unreliable.

And finally, still one other problem with the Earth's magnetic field. One with which we will have to deal with more directly.

Only at 2 North/South lines in the northern hemisphere, does the compass needle point to True North. One is through Russia and the other is Wisconsin & Alabama in the U.S.. At all other places on the globe, the Compass will either point East, or West, of the actual Geographical True North, by an angle called "Magnetic Variation" or "Declination." This is the name given to the angle, between True North, and Magnetic North. Magnetic North is located about 1,000 miles South of Geographic North, near Bathurst Island, centered off the Northern coast of Canada above Hudson Bay.

In the continental United States, this angle of error is going to be between 25 Degs East, to about 23 Degs West of True North. Alaska's declination ranges from 15 Degs East to 36 Degs East.

And to top it all off, these values will slowly change over time, as the earth's continental drift moves the crust over it's molten mantle at 2 to 4 inches per year. Along with that, on June 27th, 1992, the San Bernardino Big Bear 6.2 earthquake caused the San Bernardino Mountains to jump over the valley

by 1.5 feet in places. This in turn twisted the valley floor slightly, and caused the declination of the valley to actually gain 1/2 degree in 30 seconds, from 14.75 Degs to 15.25 degrees.

To find a declination for an area you would wish to visit, you can always call an airport's Flight Control Center, 24 hours a day, to get a very accurate Declination. Even the best Topo Maps can be slightly off.

So what I need you to under stand is when using a Compass, you have to always compensate for declination one way or another. You can either draw "Magnetic Lines" on your maps, or let the compass correct for Declination for you.

DEVIATION.
A compass can give an incorrect reading if it is in the presents of iron, steel, or the presents of electrical wires that makes a local magnetic field. These will prevent the Compass needle from correctly pointing to Magnetic North, and can help throw you way off course. When finding North, watch out for nails in picnic tables, Belt buckles, Knives, Lighters, Karabiners, and even red rocks (which happen to contain iron), that you may set your compass on. And forget even trying to use the compass to orient a Map on the hood of your car.

BEARING, also called Azimuth.
Is a horizontal angle, that fixes a direction in respect to True North, (or Magnetic North), as measured in a clockwise direction on the Compass Rose.

Some Compasses use a different system of direction expression, than Azimuth, found on your regular Camping compasses.

One of these other types is called the QUADRANT SCALE Compass. The graduated dial is still marked off with 360 degrees all the way around, but it is very different from the normal Azimuth Scale you may be used to.

The Quadrant Scale system calls North - 0 degrees, and increases to 90 degrees at West, then decreases again to 0 degrees at South, and then increases to 90 degrees at East, and 0 degrees at North again.

Direction	Azimuth	Quad
North	0/360	0/0
East	90	90
South	180	0
West	270	90

Directions are given in quadrants such as "North 20 degrees East" (Equals an Azimuth of 20 degrees), or "North 15 degrees West"

(Azimuth of 345 degrees), or "South 40 degrees East" (Azimuth of 140 degrees) or "South 10 degrees West" (Azimuth of 190 degrees). This system is based on Polar Rectangular Coordinates, for use by Foresters, Surveyors, Geologists, Builders and Engineers.

Another system, the METRIC SYSTEM, has it's own version of the Azimuth Dial also, and it Breaks the regular 360 degree dial, into 400 Grads. This means that 90 degrees East, is also equal to 100 Grads East, and South is 200 Grads. This is further broken down into Centigrads (1/100th of a Grad), and Milligrads (1/1,000th of a Grad). These are extremely fine angular measurements, and much finer than you need to bother about in the field.

Direction	Azimuth	Grads
North	0/360	0/400
East	90	100
South	180	200
West	270	300

Another system is the military usage of the MIL. The regular 360 Azimuth degree circle, equals 1,600 mils. So East is represented by 400 mils, South is 800 mils. It is used mainly for aiming military Gunnery.

Direction	Azimuth	Mils
North	0/360	0/1600
East	90	400
South	180	800
West	270	1200

We have already talked about "clicks." It is a forward tactical military direction expression. 90 Degrees East Azimuth equals 30 clicks, and 180 Degrees Azimuth equals 60 clicks.

Direction	Azimuth	Clicks
North	0/360	0/120
East	90	30
South	180	60
West	270	90

It is unlikely that you will need to know these other Azimuth Markings, but they do exist, and show up occasionally.

The type of graduated dial used by most Outdoorsman is the AZIMUTH SCALE. A system of 360 degrees.

Just to make you aware, there are a few types of "bearings," and is important that you know the difference between them. Look at your map's Declination Chart. There are True Bearings (measured from True North), Grid Bearings (measured from Grid North), and Magnetic Bearings (measured from Magnetic North). These expressions are referring to the "Degree of Angle" between a

"Direction of Travel," and the angle of either Grid North, Magnetic North, or True North. So any Direction can be expressed as 3 different bearings, and still be correct. It becomes important that all bearings be defined as 260GN, 50TN, or 180MN.

In addition, there are Map Bearings, and Field Bearings.

A Map Bearing, is a bearing taken while looking at a Map, to be applied to the land, and can be expressed as Grid, Magnetic, or True North.

A Field Bearing is taken while looking at the landscape, to be applied to a map, and can also be expressed as Grid, Magnetic, or True North.

In this Syllabus you will be taught "True Bearings" in relation to "True North" only, mostly because maps are True North.

First the bad news... Using a Compass to locate North in the field (Field Bearing), is different than finding North with a Map (Map Bearing). This is due to the Magnetic Declination. The Map (True North), and the magnetic needle (Magnetic North), speak 2 different languages.

Whatever distance you travel, for each degree of declination you don't account for, you will be off your course 1/60 of the total distance traveled.

1 Deg = 88 feet off course at 1 mile out.
2 Degs = 176 feet off course at 1 mile out.
4 Degs = 352 feet off course at 1 mile out.
8 Degs = 704 feet off course at 1 mile out.
15 Degs = 1,506 feet off course at 1 mile out.

This means that at 15 degrees declination, at 1 mile out, you can be 1/4 of a mile off course. Just imagine how important Declination would be in Alaska at 36 degrees...

To correct for these differences, mathematic conversions are necessary. We need to "add" or "subtract" our local Declination, to our bearing, every time the Compass is used...

In the western United States, for Map Bearings, to convert to Field Bearings, add your local declination to get the correct Magnetic Bearings to be applied to the land. For Field Bearings, subtract your local declination to apply to the map. On the east coast, the opposite math needs to be preformed. Let's face it, in the real world of the wilderness, it is NOT EASY to remember when to add and when to subtract.

Now the good news... There is however, a couple of ways to completely eliminate the mathematical differences between Magnetic North and True North, so you never have to think about

them again.

The "Magnetic North method" uses a series of parallel lines that YOU draw on the Topo Map, parallel to the Declination Chart at the bottom of the Map. These new drawn Map lines then represent your new "Magnetic Meridian lines" pointing to Magnetic North, so that the Compass needle, Compass Housing, and the Map, all speak the same language. From this time forward, the Compass is used "Magnetic Needle" to "Magnetic North on Housing" to "Map Magnetic North" to get a Bearing, and we can completely forget declination. All bearings are then given as degrees from Magnetic North to your Bearing or heading. Be sure to mark it MN when you write it down.

"Boxing the Compass," is the oldest way on the planet to orient a Map using a simple Fixed Dial Compass, having no Magnetic Meridian lines drawn on the Map. The map is placed on the ground, and the Compass is placed on the Declination Chart. Together the Map & Compass is then turned until the needle completely covers, or "Boxes" in the Magnetic Declination arrow on the Declination Chart. The map is now oriented to the lay of the land. This must be done every time magnetic bearings are to be taken with a simple compass.

Some of the drawbacks to the Magnetic Method, are that the Declination Chart line is only 1 inch long. A slight misalignment of a line drawn squarely across the Map, could result in a sizeable error.

Also, in the cases of very small degrees of declination, be sure to take the time to MEASURE the exact number of degrees the Declination Chart specifies, before drawing all these lines in. Sometimes the declination in an area is small, and Map makers exaggerate the visual Declination Chart for the sake of clarity. So measure the actual degrees along the center line of the map with the Compass Rose before drawing any lines.

Another problem is that a Topo Map is a picture of a Curved Surface, so straight lines drawn across it may be accurate in one corner, but off in another. The Navigational Chart for Lake Tahoe shows the Magnetic Declination as 15.75 at the southern end of the lake, and 16.25 at the northern end (in 1960). I'm talking about a lake that is only 20 miles long. That is about the same area covered by a 15 minute Topo. So drawing straight lines, on a 1x2 degree map, are going to be way off.

It occurs to me that the Magnetic North Method, without those lines, can't be used very accurately with every day car maps either. I need a method I can use with my Topo maps, AND every other map too...

The TRUE NORTH METHOD...
The other method commonly used, which does the same job as the Magnetic North Method, is the True North Method. A small strip of tape, on the face of Needle Compass Rose, at the proper Declination, can turn your compass into a True North Compass.

Right now, get up, and place a 1/8 inch strip of tape from the center of your compass, to the correct degrees of declination in your area. (Riverside, Calif, is 15.25 Deg.) This will be necessary in order to follow along with this instruction.

From this time forward, there are only 2 rules:

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1. When taking Field Bearings... Put the "Compass Needle" to "Tape," - Always!

2. When taking Compass Bearings... Put the "Housing Meridian Lines" to the "Longitudinal Meridian lines on the Map," - Always!

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That's it... That's all there is to it...

Read them again...

Now the "Compass Rose," "Base Plate," and the "Map," any map, all speak the same language of True North, while the "needle" still points to MN. There is no need to draw lines on any map, and the need to "Box the needle" is eliminated. All bearings are then given as "True North Bearings," and you can forget the declination, because the compass has included it in it's measurement. Be sure to mark it TN when you write it down.

HOW TO WALK A BEARING.
Try this outside. Pick the Compass up and place in the palm of your hand. Turn the Azimuth Ring dial to some random number on the Compass Rose. Now holding the Compass chest high in front of you, turn your body and Compass together as a unit, until the Needle points to the tape. Now look out beyond the compass, straight ahead. The further out you can look beyond your destination the better. Choose some "landmark" or "Steering Spot" which is in line with the direction you wish to travel, as pointed to by the "Direction of Travel Arrow" on the Compass Base Plate. You would then put the Compass away, and walk to that landmark, or spot, without looking at the Compass again. When you get there, then use the Compass to locate the next bearing, and locate the next landmark, then put the compass away again. It is just that easy... (Note do not walk while staring at the Compass Needle, you might stumble over something, or get bitten by a snake, or eaten by a bear! Watch where you are going in the wilderness. Use "Steering Marks"!)

Here is another exercise to try outside to show you just how trust worthy a compass really is. Get all your boys out to do this one. Place the end of a stick into the ground directly at your feet. Set your COMPASS ROSE, or Azimuth Ring, to some arbitrary direction between 0 and 120 Degs. (Let's say

60 Degs.) Now turn your body and Compass as a unit till the Compass Needle points to the tape (Declination). Face this direction and walk this bearing for a nice evenly spaced 20 Paces... (Double steps, about 100 feet). Then stop.

OK. Now look at your Compass again. Add 120 Degs to the first arbitrary direction you used, (Like 60 Degs + 120 Degs = 180 Degs.) and set this new Bearing on your Compass Rose. Again, turn your body and Compass as a unit till the Compass Needle points to the tape (Declination, Not to North). Walk another 20 Paces... Stop.

Now one last time. Look at your Compass again. Add yet another 120 Degs to your last setting (180 Degs + 120 Degs = 300 Degs), and reset your Compass Rose. Turn your body and Compass till the needle points to Declination again, then walk 20 Paces again... Stop.

If your pace was smooth, and evenly distanced, at your feet should be that stick... This test is very good practice. It can instill a lot of faith in the compass...

Try 4 turns of 90 Degs each, or 5 turns of 72 degrees each.

BACK BEARING.
A Back Bearing, means to reverse direction along the way you just came, or back tracking. Simply add or subtract 180 degrees from your present bearing, and turn the DIRECTION OF TRAVEL ARROW to this new heading, turn around and walk back the way you came.

Or another way with an Orienteering Compass, you can simply hold the whole compass and Base Plate backward in your hand, without touching the Needle Housing, and follow the Base Plate back the way you came.

HOW TO ORIENT A MAP
First of all, find True North with the Compass, and align the Needle to the tape (Declination, Not North). Open the Map and place it on a rock or the flat ground. Turn the Map so that the Compass's Meridian Orienting Lines and the Map's True North are aligned. Now the map matches the landscape exactly.

HOW TO GET A MAP BEARING, FROM THE MAP, TO THE LANDSCAPE.
Simply place the Compass on the open Map. Put the rear-corner edge of the Base Plate directly on your present location. Move the straight edge of the Base Plate, into the direction you wish to travel. Now turn the Compass Rose till the Needle Housing, Meridian Orienting Lines match the Map's North/South lines. That's all there is to it...

Now
pick up the Compass and hold it properly, and turn it and your body as a unit, till the needle points to the Declination Tape (Not North). The "Direction of Travel Arrow" on the Base Plate now points the way to go. Sight on a distant

object beyond your target, and fix it in your mind. Put away the Compass and walk towards your destination along your landmark bearing line.

As you walk you may find your self side stepping obstacles in your way. Any time you step to the left or to the right of your Bearing, say to travel around boulders, or clumps of foliage, to reach your destination landmark, you practice CIRCUMNAVIGATION. Your distant visual landmark brings you back to your correct bearing. This is why "Steering Marks" are SO important.

Note, when using an Orienteering Compass, to get a MAP BEARING to a FIELD BEARING, the -Map does not have to be oriented to North!

HOW TO PLOT A FIELD BEARING ONTO A MAP.
Hold your Compass properly, and turn your body and Compass as a unit, to the direction you have visually decided to travel in. Now, turn the Compass Rose till the Needle points to the Declination Tape (Not North). This is called "taking a bearing." Then place the Compass on an oriented (or un-oriented) map. Turn the whole device around until the MERIDIAN ORIENTING LINES, on the Needle Housing, line up with True North lines on the map (North to North, totally ignore the magnetic needle at this point). Align the rear-corner of the BASE PLATE to your present location, and draw a line in the direction you just measured from the field. This is the direction you are looking at to travel in. That's all there is to it...

BIANGULATION TO GET A "FIX" ON YOUR PRESENT LOCATION.
Look around outside and find a prominent point in the landscape that can be identified on your Map. It can be a lake, mountain peak, road intersection, river fork, water falls, railroad track, anything that can be seen both on the Map, and on the landscape. Then hold your compass properly, and turn your body and the Compass, till the DIRECTION OF TRAVEL ARROW points to this prominent landmark feature. Now turn the COMPASS ROSE around until the Needle points to the Declination Tape (Not North), and get a reading or bearing in degrees. Ok, now place the compass on your oriented (or un-oriented) Map, and align the MERIDIAN ORIENTING LINES with the Map's True North. Draw a light line from the landmark back towards your position. Now take a 2nd reading from another prominent landmark about 90 Degs away from the 1st bearing. Again turn the COMPASS ROSE till the Needle again points to the Declination Tape (Not North). For a second time, place the compass on your Map and align the MERIDIAN ORIENTING LINES with the Map's True North, and draw a light line from the 2nd landmark back towards your position. Where the lines cross, is your exact location.

TRIANGULATION.
This is the same as Biangulation, only that you take a 3rd reading from the landscape, and mark it also on your Map, as a form of checking your location. This works best if the readings are about 60 Degs from each other, and specifically not

close together.

PACE

Did it ever in your life, make you curious as to how come a statute mile is the uneven distance of 5,280 feet? Well, that's the distance that 1,000 paces would cover by a Roman foot solder 200 years B.C.. Our modern word "Mile" came from the Latin phrase, "Mille Passus," meaning "1,000 Paces." Today, this measurement is still very handy.

A Pace is the double-step distance between 2 right, or 2 left foot steps. It is about 5 feet in an adult, 4-1/2 feet in older children, and 2-1/2 feet in 10 year old's.

There is roughly 250 Adult PACES in 1/4 mile, and 500 PACES in a 1/2 mile. It is amazingly accurate. Everybody has a slightly different pace, so measure your own by marking off 100 feet and see how many paces it takes you to travel 100 feet. It should be from 18 to 21 paces.

Time and distance are directly related to each other in navigation.

time = distance / speed

The work done to walk straight up a steep hill 100 feet, can be greatly reduced by increasing the distance over which the work is to be done, as in switch-backing the hill. That way the same amount of work is done over a longer time.

work = time * horse power

Distance judged by time alone in the wilderness is unreliable due to the differing kinds if terrain. It takes about 20 minutes to walk a mile on open highway, 30 minutes to walk through open woods, 30 minutes for thick woods or foothills. So your best bet is to not use time, but use your PACE to measure distance in the wilderness instead.

During the planning stages of a trip, it is wise to plan each nights stay at each camp site. The time and distance can be an important bit of information. But they are tricky to figure if you don't have some idea of the time it takes to pace a mile.

The standard
times to calculate travel time with a 35 pound backpack on is...

Ascending - 1 hour for every 2 horizontal miles, plus 1 hour for every 400 vertical feet of elevation gain.

Descending - 1 hour for every 2 horizontal miles, plus 1/2 hours for every 1,000 vertical feet of elevation lost.

This rate takes into account for a 10 minute break every hour.

The health of your group, the age of the individual, the type of landscape walking through, and expected weather, will all have an effect on the amount of time its going to take. So the above times are only a rough idea.

CIRCUMNAVIGATION

While you are walking on a Bearing, you may come to an obstacle of some kind. It may be a lake, a clump of cactus, a swamp, a canyon, or a steep hill. Something you can't go through.

One method is turning 90 degs to the right or left of your present course, and taking a new bearing. Then while walking away, count every right foot step, till you clear the edge of the obstacle. Then turn and take another bearing at -90 degrees, to parallel your original heading. You do not have to count again yet. When you have gone far enough to clear the obstacle on this parallel direction, turn -90 degrees and take a new temporary Bearing. Walk, again counting every right foot step, until you have made the same number of paces that you first counted. When you have reached the pace count, turn +90 degrees, and resume on your original Bearing, to continue on your way.

Instead of taking the chance of forgetting your original bearing after you move the setting, another way of finding that 90 Degs to turn, is to take advantage of your Compass's base plate.

When you get to that obstacle, hold the Compass level, and sight along the back edge to a distant object (Steering Mark) at 90 degrees from your course, and count your steps toward it.

Then sight along the right edge of the Compass and walk for enough distance to clear the object.Then sight along the bottom edge again - recounting your steps back - and get back on your original heading.

DOG LEG (Advanced)

Another method involves taking only a +45 degree turn, for some number of paces. Then when the obstacle is cleared, turning -90 degrees, counting your paces again, where you turn +45 degrees to resume your original Main Bearing heading.

When you become really good at circumnavigation, you can set a Bearing. Then circumnavigate at +45 degrees in one direction of an obstacle for some number of paces. Then turn back -45 Degs to parallel your original main bearing for a while without counting. Then turn another -45 degrees, and recount your paces again, back towards your main bearing. Where you again turn +45 degrees to resume your original course. Cake Walk!

Actually, hiking can rarely ever be done in a straight line, Mankind has a tendency to walk in circles, and the land has so many irregularities. You improve the odds of reaching your destination if you...

1. Make careful, and accurate sightings on both the Destination Landmark, and all Intermediate Landmarks.

2. Follow the DIRECTION OF TRAVEL ARROW and NOT the Compass Needle when walking.

3. Recheck your bearings carefully to avoid an accumulation of small errors. If possible have more than 1 person take Bearings.

4. Use bearings only over short distances when possible.

5. Aim for a "line" on a Map rather than a "point" when possible. These are called "handrails." It is easier to hit a stream, a road, or a crest, than it is to hit a waterfall, or water tank.

6. Continuously plot your progress on a Map.

DEAD RECKONING, Aiming Off, or Offset Course. (Advanced)
This is a technique involving the knowledge of distance, in Paces, between you and some destination on a Map.

By calculating the correct number of paces, and then walking deliberately to miss the object on one side, you keep track of exactly where that destination is. It give you a bit of a "handrail."

For instance, if you knew you were say 300 paces west, outside of camp, and you headed directly east, into camp, in thick brush you may, or may not, hit the camp directly head on. You most likely will end up a little North or South of the camp site. But you notice that after arriving in the new location, you still don't see the camp. Now which direction do you go from here? Try all of them!!! You could very conceivably spend quite a bit of time looking around without finding anything.

By purposely walking 10 degrees off to one side (south of the camp), and walking east while counting the 300 paces. By turning 90 degrees north like clockwork, you will measurably be in the vicinity of the camp. This greatly increases your chances of hitting the camp.

CONTOURING is a method of walking around an obstacle, such as a hill, by keeping at the same elevation, and thus following the contour. This reduces the work expended by climbing and descending the hill, keeping you from exhausting yourself.

FOG BANK READINGS.
The #1 first rule of backcountry hiking is -

Never get lost in the first places.-

This may bring up the question of "how," but it is important that everybody needs to "know where they are on the map" before they

first hike out that day. And every so often "along the trail" they need to check exactly where they are.

It is best to have the map & compass close at hand in a shirt pocket, and not stuck in a backpack pocket somewhere. You must you must be able to get to your Map in 5 seconds, and your Compass in 10.

In fair weather, you might not have any need of your compass at all. You may be able to orient yourself with only with a Map and landscape features.

But if the weather deteriorates while your on the mountain, and limits your visibility, you'll need to heavily rely on your compass by setting the bearings you want to follow from the map.

The mountains create their own weather and sudden Indian Summer snowstorms do occur regularly in the Sierras around June and August. On a 2nd or 3rd day out, it can take only 3 seconds for a cloud bank, rising over a mountain spine, to pop up over the 10,000 foot, marmont infested, rock quarry you're on, and leave you with a reduced visibility of 0 feet.

And do not forget to look behind you as you travel. You should be concentrating more, on what you have passed, than where you are going. The landscape looks very different looking back the other direction. Turn around and look at once in a while.

It is unlikely that a Compass will become damaged, but it is always possible. If you go into the wilderness, always carry another compass as back up, preferably carried by someone else. One person may become incapacitated, so there should always be another who can also navigate safely.

OTHER METHODS FOR FINDING NORTH.
A stick, driven into the ground, so that the stick points directly at the sun, and has no shadow. Within 20 minutes, a shadow is forming, and a line is drawn in the dirt to continue the shadow east and west. The stick then points away from North.

At night, the big dipper's 2 bowl stars point to the fainter pole star called Polars. What ever latitude on the globe you observe Polaris from, is the same number of degrees above the Northern horizon that Polaris will be found. (i.e. at 34 Degs N Lat... Polaris will be seen at 34 degrees above the Northern horizon.)

The head of winter constellation Orion points to the North.

Tree stump annual growth rings are usually thicker on the Northeast side of the cut.

Away from moist areas like stream beds, moss has a tendency to grow on the shady North side of a tree. In damp areas, however,

it grows all over the tree.

Lichens and Algae on boulders, grow more on the sunny Southern sides.

WEATHER FORECASTING USING A COMPASS

Weather is a fairly complicated subject that could use an entire training session of it's own. However any good Encyclopedia can help you better understand the fundamentals of Meteorology and Weather. Whether you captain a yacht, hike in the wilderness, or just sit on your porch, weather is one of those unique topics that can enrich the rest of your life.

Very briefly however, the Sun is the energy source that heats up the engine of our atmosphere. As the tropical air at the equator heats up, it slowly rises up and over the heavier, colder, polar air, that is sinking at the poles, slipping southward.

At the same time the heavier cold air is sinking in the atmosphere, the Earth is spinning, dragging the atmosphere along. Due to centrifugal forces, and the Coriolis (kor-e-O'lis) Effect, this slings a vortex of more dense polar air towards the equator in a 600 mph curved path called the "Jet Stream." This causes the Trade Winds that blow from West to East along the latitudes of the western United States.

The warm and cold air masses do not mix well due to the differences in temperature and moisture, and pockets of Higher & Lower air pressure develop. A High is literally where air just piles up on top of itself as it spins off of the Jet Stream. These Highs and Lows of atmospheric pressure, in turn create the weather fronts reported on by the News and Weather Services during the day.

As these atmospheric Highs and Lows pass through an area, there are characteristic wind, and cloud patterns that are observable, which can really aid you in forecasting the next 12, 24, or 48 hours.

In areas of High air pressure, the air circulates Clockwise (CW) around the center, and out away from center.

In areas of Low air pressure, the air circulates Counter-clockwise (CCW) around the center, and into the center.

This direction of -Low- air circulation is very important. One way to remember this, is when the clouds are forming, and the weather is getting worse (a Low), turn and face the wind head on. The central area of Low Pressure will be on your right hand side, at 90 Degs from you.

Basically what this means is, if the winds hit you out of the

West, then the "Low Pressure system" will pass-by you to the North. It may give you a short light rain, or no rain at all. However, if the wind has an element of South in it, look out. It may be coming directly your way.

Winds out of the Southwest, South, or Southeast, mean that the Low is directly West of you. The Trade Winds will be carrying it over your area in just a matter of hours. You should be able to see signs that it is either a Warm, or a Cold Front, and whether it will pass over you. Depending on the season, this may be a direct warning to get your group down out of the mountains as soon as possible, and without delay. Your first sign of trouble may be a cold afternoon wind, blowing along the ground, out of an unusual direction, watch and feel for it.

Wind Direction	Barometric Pressure	Weather Prediction
N to E.....	Rapid Fall..	Gale Due In Hours, Snow or Heavy Rain Continuing.
NE to E.....	Rapid Fall..	Rain Or Snow in 12 to 14 Hours.
NE to E.....	Slow Fall...	Rain in 2 To 4 Days, Or Winter Snow Within 24 Hours.
NE to SE....	Rapid Fall..	Rain With High Winds, Then Clearing Within 36 Hours.
NE to SE....	Rapid Fall..	Rain In 12 Hours With Wind.
NE to SE....	Slow Fall...	Rain Continuing.
NE to SE....	Slow Fall...	Rain In More Than 12 Hours With Wind.
E to S.....	Rapid Fall..	Severe Storm Due In Hours, Then Clearing.
SE to S.....	Rapid Fall..	Rain Within 12 Hours With Wind.
SE to S.....	Slow Fall...	Rain Within 24 Hours.
SW to S.....	Slow Rise...	Clearing Within Hours, Then Fair Weather For Days.
Moving to W.	Rapid Rise..	Storm Ending, Clearing and colder.
NW to SW....	Rapid Rise..	Fair With Rain In 48 Hours.
NW to SW....	Steady.....	Fair For 24 To 48 Hours.
NW to SW....	Slow Fall...	Fair And Warmer For 48 Hours.

Highs are fair weather pockets of air, after the front passes,

and not usually a problem. High Cirrus or "Mares Tails" will give about 48 hours warning before the passing of a Warm Front. It may sprinkle a little, but will most likely not be severe. Warm Fronts generally move more slowly, at about 8-10 mph.. Rain will last for about 24 hours or so, and in 48 hours temperatures will warm up.

A Cold Front moves much faster at about 15-40+ mph.. It wedges and pushes the warmer pocket of air along in front of it, and can generate huge towering clouds, with very severe rain, hail, and even lightning.

A Cold Front does not have Mares Tails. Instead takes on the characteristic form of a "line of clouds" that comes in from the coast, or creeps up over a mountain range. It carries, and dumps lots of rain, and can easily form Cumulonimbus Thunderheads. (To calculate the distance away from a storm having the flash and sound of thunder, count the interval between the lightning flash, and the boom, and allow 5 seconds for each mile.) A Cold Front is exactly the kind of weather to avoid from November 15th till March 31st at 6,000 feet.

As the Frontal Zone of a storm passes over head, the wind will noticeably shift 90 Degs. A Cold Front type storm will be over. A Warm Front storm however, is only half over. This has to do with the way clouds are made in the Frontal Zone itself.

In a Warm Front, the warm air is riding up and over the cooler pocket of air on the ground, and is pushing it along more slowly. The clouds of a Warm Front are almost horizontal at 200 miles out, as they gently slope back towards the ground. These are Crrius and Straitus Clouds typical of Warm Fronts.

As the Warm/moist air and the Cold/dry air meet in the "Frontal Zone," condensation takes place forming fog, and falls to earth as rain. So when this long sloping Front passes overhead, the wind will shift, but it will continue to rain for a bit longer.

What makes it really interesting is that not all weather patterns are predictable. Even T.V. Weathermen are only correct 80 or 90% of the time. Besides that they can only see about 36 to 48 hours a head. Always be prepared with rain gear! Surprise storms do occur regularly, but let me clue you, the surprise of weather is wonderful.

It's going to be up to you. Learning the patterns of weather, and trying to out think it, is interesting. Predicting weather is a skill of the natural world, that can be as important as using any map & compass.

"I only went out for a walk and finally concluded to stay out till sundown, for going out I found, was really going in."

John Muir

****
* IF YOU BECOME LOST *
****

The act of traveling to some unknown place, from some unknown place, can only be called one thing... LOST! If you should find yourself mixed-up, and in unfamiliar territory, don't call yourself lost right away. You may just be slightly disoriented for a few minutes. What ever else you do, don't panic. Panic can cripple your ability to think rationally, and greatly reduce your chances of ever getting out safely.

You can take heart. Every year, thousands of people become lost. Luckily, most of them figure out where they are, or are found by Rescue Teams within a few hours or days.

-Sit down- and relax. Take your time. Have a deep breath or two. Eat a candy bar, chew some gum, drink some water. Think things over and stay quiet for a few minutes. Look around, and enjoy your surroundings.

Try to remember how you got there. You may remember how strange the trail looked when you accidentally took that wrong turn onto an animal trail, or maybe you must have simply missed the trail sign. Study the Map and landscape for clues, shoot some bearings, and above all STAY TOGETHER AS A GROUP. The buddy system is not only for swimming. Never leave your gear anywhere as you scout around the area. You may not be able to find it once you leave it, and it is your life line. Climb a tree or hill to see where you are. Get your mind working for you, think positive. Speak up, and get everyone involved, someone might have seen something you have missed.

When someone on foot first recognizes that they may be lost, they are usually not so far out that they can not be located, or even relocate themselves in a short time.

The major problems begin when a lost hiker, who knows he's lost, keeps right on walking along, thinking he'll figure out where he is. At the same time, he's increases the confusion for the Search & Rescue teams. Sadly, all too often, the victim walks entirely out of the search area.

Keep a cool head. Having a good mental attitude can mean the difference between a pleasant unscheduled camp out, or a life or death survival situation. Things are usually not as bad as they first appear.

TEACHING SCOUTS HOW TO STAY FOUND.

[] First, concentrate on teaching kids what to do if they suddenly feel lost... S T O P ! If they can't figure out where they are, tell them to make lots of noise. 3 of anything, 3 whistle blasts, 3 rock bangs, means H E L P! Do not move! WAIT TO BE FOUND! And keep making noise.

[] Always have them tell somebody if they have to leave the trail for any reason. Even to stop and rest. Always use the buddy system in the wilderness.

[] Explore only inside set camp boundaries, and enforce those boundaries.

[] Show them how to recognize trail signs along the way. Use their un-quenchable thirst for details. Point to features along the way both large and small.

[] At rest stops, and in camp, play games about things around them. Have them close their eyes and name things. Have them name landscape features on the Map. As you hike show them your progress along the way on the Map to check their position.

[] Have them look around and find a prominent feature of the landscape that can help them stay found.

[] Teach them how to use a Map and Compass and let them take turns leading the group.

PLANNING A TRIP.
You have placed a hike on the Troop calendar. There is this great hike you have always heard about. So it's time to make plans for everybody to make that hike. Your planning starts right there, and should not end till you are back safely from the trip.

There are all kinds of books, and trail guides, that you can purchase. These will tell you about almost any hike. They are most often a great place to start. You will be able to get a good idea of what others think about that dream hike of yours. Many times they will give a little history about the area, and point out some interesting sights along the way. You can also learn about some possible side trips to places that you just otherwise would have passed by. Many times these guide books will tell you exactly where the hike starts, how to drive there, and if the campgrounds have water close by, etc.. They can be wonderful, but do remember that the older the book, the more likely that things have changed.

Often these books will come with a general Map of the area. They show all the hikes that are listed in the book. You can get a better feel about the hike you want to go on, and about other hikes in the general area. These are good to study in case you have to alter your plans along the way. There might be something else that you decide you want to do, like go swimming. It maybe only a short distance from where you plan to be. These Maps can give a fair amount of detail, but they should not be used instead of the Topo for the area.

Many agencies will make Maps showing all the hikes in their area of control. The Forestry Service does this here in California. The cost is 2$. These often have quite a bit of detail, but they are not as informative as a Topo Map. Forest Service Maps come in all sizes, and are often some of the

most updated facts on that area. There are also, many times, short footnotes on each hike, and about water conditions. Many times they will explain the Wilderness Permit system, or show you which Fire Permit you'll need to get, and give a few of the regulations for that area. If trails are closed at certain times of the year they will often be noted.

The people who have control over the area where your hike, are often the best source for current information about that area. Things can really change from year to year, and Topo Maps just can't keep up. Thru talking with people who know the area well, you can find out information that no Map can show. There may be a short sheer cliff that the Map doesn't show. The water routes may have changed over time. Bears may be raiding only certain camp sites and leaving others alone. Or there may now be a shortage of water in the area. These are things you'll need to know before you leave, and not just find them out on the trail.

Use and study all the Maps you can get your hands on of the area. Road Maps, Forest Service Maps, Trail Guide Maps, and even Complementary Visitor Center Maps. Something may happen on the trail that may cause you to change your route, or come out another way. In an emergency you may be able to save time in getting help by going cross country, instead of the way you came in. You should know all roads around the area.

Make a written plan of events with times and locations. Add in some time for the unexpected.

Let everyone see the plan. Leave it with someone back at home, with instructions of what to do, if they don't hear from you by a set date and time.

Also let all parties know who to contact in case there is an emergency at home, and they need to get word to your group. It is also good to leave a Map at home, highlighting your route.

Make some plans for an alternate hike. You may need to make a change due to events beyond your control. Weather can very easily make it so you can't hike in one area. Yet maybe by moving over to another trail, just a few short miles away, you can still go on a safe outing. Never feel that you have to make that one hike right this instant.

Is this hike of a nature that everyone in the group will be able to make it, or will there be a need for some special training to get everyone ready? Don't let someone go, if there is a valid reason why they "might" not be able to make the hike. Flu & Colds tend to get worse up on the mountain. Know your limits. The more you can learn about an area, and your groups limits, the safer your hike will be. Make everyone going, study the maps, and put some input into the planning. Find out what they want to see. Make your Scouts feel like this is their outing, not the leaders. BSA requires 2 adult leaders, 1 of

which has to be 21 years of age. That no fewer than 4 individuals go on any back country hike or camp out, and file a Local Tour Permit with BSA.

Stop by the Ranger's Station on the way in, let them know your group is on the mountain. Collect all the information you can. Then go out there and enjoy the back country with all it has to offer, and wisely plan ahead so you can enjoy the beauty around you...

ORIENTEERING was developed in Sweden as a sport. It is a game that improves map reading skills. and is a competitive navigational "run for your money." Each player, outfitted with a map, a compass, and a set of clues, takes off at spaced intervals, to locate a series of control points, in a timed race. Mental and physical skills are needed for this type of game. Someone skilled in the use of map & compass, with care and quick thinking, can off set their own weakness in strength or endurance.

Players need to understand all about map reading, bearings, map scale, map orienting, direction, symbols, and contours.

In "Point To Point Orienteering," all of the control points are visited in the same sequence by players.

In "Score Orienteering," none of the control points need to be gone to in any certain sequence. A different number of points are given to each control, depending on the amount of difficulty in reaching them. Some controls are placed far away from the start. Maybe on the other side of a stream, or the other side of hills. There is usually more control points than time in the event, so that no one can reach all of them.

In "Line Orienteering," the whole course is marked only by a line on the Map.

In "Route Orienteering," the landscape is marked off with tape, and each player marks every control point on their map.

Arrowhead Sheriff's Department Phone # (909) 336-0600
Search & Rescue Phone # (909) 386-5142
San Bernardino Forest Service Dispatch Phone # (909) 383-5588

Where to purchase Maps.
Map Distribution, Geological Survey, Box 25286, Federal Center, Denver, Co. 80225
Allied Services, 966 N.Main St. Orange Ca 92667 (714) 737-8824
Redlands Blueprint Company, 1075 W.Redlands Blvd. (909) 792-3478
Di Line Corp., 197 S."D" St. San Bernardino, (909) 683-1363
Sports Country Limited, 222 N. "G" St. San Bernardino, (909) 825-2976 Riverside Ski Sport, 6744 Brockton Ave., (909) 784-0205

A 6% grade is a 6 foot rise in elevation every 100 feet.

6ft / 100ft = .06 = 6% grade (normal)

An angle of 12 degrees as measured from an Inclinometer is a 13% grade.

```
 90 degrees    100% grade
------------  x  ------  =  (12 x 100 = 1200)/ 90 = 13.33% grade
 12 degrees     ? % grade
```

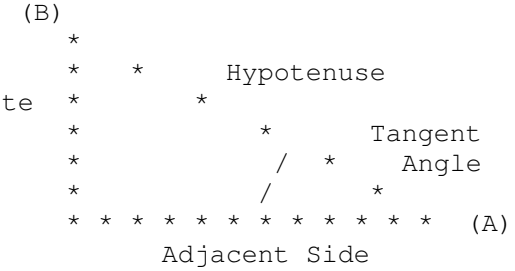
Huffin' & Puffin Steep!

An elevation change of 1,000 feet in a mile is considered respectably steep (19% grade).

1,000 ft. / 5,280 feet = .189 = 18.9% grade

INCLINOMETER measurements, part A. (Advanced)

Anybody can easily learn how to use the Inclinometer to determine the height of an object, like trees, water falls, or mountain peaks, by using very simple trigonomic mathematics.



The Distance-of-the-Opposite-Side is determined by the Distance-of-Adjacent-Side multiplied by the Tangent-of-`degree-

of-Incline', found on the compass.

or...

Opposite = Adjacent * Tangent (of Degree of Incline)

TANGENT LOOK UP TABLE

Degrees = Tangent							
1	.0174	24	.4245	47	1.072	70	2.747
2	.0349	25	.4663	48	1.111	71	2.904
3	.0524	26	.4877	49	1.150	72	3.078
4	.0699	27	.5095	50	1.191	73	3.271
5	.0875	28	.5317	51	1.235	74	3.487
6	.1051	29	.5543	52	1.280	75	3.732
7	.1228	30	.5774	53	1.327	76	4.011
8	.1405	31	.6009	54	1.376	77	4.331
9	.1584	32	.6249	55	1.428	78	4.705
10	.1763	33	.6494	56	1.482	79	5.145
11	.1944	34	.6745	57	1.540	80	5.671
12	.2126	35	.7002	58	1.600	81	6.314
13	.2309	36	.7265	59	1.664	82	7.115
14	.2493	37	.7536	60	1.732	83	8.144
15	.2679	38	.7812	61	1.804	84	9.514
16	.2867	39	.8098	62	1.881	85	11.43
17	.3057	40	.8391	63	1.963	86	14.30
18	.3249	41	.8693	64	2.050	87	19.08
19	.3443	42	.9004	65	2.145	88	28.64
20	.3640	43	.9325	66	2.260	89	57.29
21	.3839	44	.9657	67	2.356	90	infinity
22	.4040	45	1.000	68	2.475		
23	.4245	46	1.036	69	2.605		

HOW TO FIND THE HEIGHT OF A TREE.
First, stand next to the tree, and count out some number of paces away from it. (5, 10, 50 etc.) Say 10 paces this time.

Stop, turn, and take an Inclination reading on the tree from eye level. Say the reading is 28 Degs.

(Knowing that my pace is, 100 feet equals 18 paces.)
The distance to the tree is...

$$\text{Ratio : } \frac{\text{18 paces}}{\text{10 paces}} = \frac{\text{100 feet}}{\text{? feet}}$$

Show Work...
(10 paces * 100 ft = 1,000) / 18 paces = 55.5 feet from base of tree.

The Tangent of 28 degrees is .5317
     (as determined from the Tangent look up table.)

The tree height from your eye level is...

                          55.5 ft * .5317 = 29.5 ft

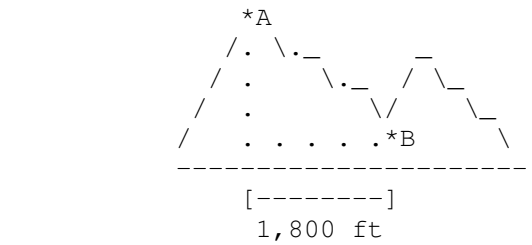
Now add your height from the ground to your eye level (5 feet)...

                              29.5 ft
                             + 5.0 ft

                  The tree is 34.5 feet tall.

INCLINOMETER measurements, part B. (Advanced)

As another example on how to use this feature, lets say that your group is up on a 8,540 foot Peak (A). You can look down into a river gorge (B), that just doesn't look all that very far away. You would like to send people for water, but you first need to determine how far away the river is. How long it will take your people to reach it, and then get back.



Step 1...
  Determine by Triangulation your exact position on the map.

  You find while checking the map, that you are 1,800 feet
      (1/3 mile) from the water.

Step 2...
  Take an Inclinometer reading in Degrees down to the river.

  You find the inclination is 13 Degs.

Step 3...
  Convert "Degrees" into "Tangent."

                  13 Degs = .2308 (tangent look up table)

Step 4...
  Determine the difference in altitude.

1,800 feet * .2308 = 415.44 feet.

So the river is 416 feet down, at 1/3 of a mile out.

Step 5...
  Determine the time it will take to get there and back.

5a) Calculate for Horizontal element of hike.

Down Hill Rules =
1 hour for every 2 miles (10,560 feet), plus (+),
1 hour for every 1,000 feet lost in elevation.

(There are 5,280 feet in a mile.)

$$\text{Ratio: } \frac{10{,}560 \text{ feet}}{1{,}800 \text{ feet}} : \frac{60 \text{ minutes (1 hour)}}{? \text{ minutes}}$$

Show Work...
(1,800 feet X 60 = 108,000) / 10,560 feet = 10.23 minutes
Horizontal

5b) Calculate for Vertical down hill element of hike.

$$\text{Ratio: } \frac{1{,}000 \text{ ft}}{416 \text{ ft}} : \frac{60 \text{ min}}{? \text{ min}}$$

Show Work...
(416 ft X 60 min = 24,960) / 1,000 = 24.96 minutes
Vertically (Down)

So it will take...

10.23 minutes horizontally
+24.96 minutes vertically down

35.19 minutes to get down to the water.

5c) Calculate for the Vertical up hill element of hike.

Up Hill Rules =
1 Hour for every 2 miles, plus (+),
1 Hour for every 400 ft gained in elevation.

$$\frac{400 \text{ ft}}{60 \text{ min}}$$

Ratio: -------- : --------
416 ft ? min

Show Work
(415 ft X 60 min = 24,960) / 400 ft = 62.4 minutes (up)

So we have...

10.23 min horizontally
+62.4 min vertically (up)

72.63 minutes to get back up from the water.

The Round Trip will be about...

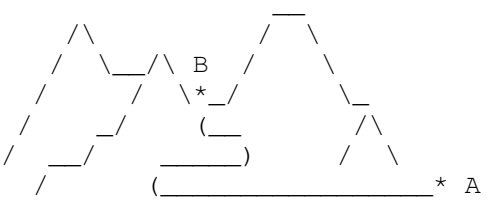
35.19 minutes down
+72.63 minutes up

107.82 minutes = 1 hour, and 49 minutes (or about 2 hours)

Maybe you should wait till the morning to fetch that water instead.

INCLINOMETER measurements part C. (Advanced)

Let's say that 2 hours before sunset, your group can't decide whether to make camp at their present location (A), or push-on to the camp at the top of the switch-backs. You as Leader, must decide how long it will take the weakest member, to reach the top, set up camp, and eat.



Step 1...
Determine by Triangulation your exact position on the map.

You find while checking the map, that you are 3,600 feet (2/3 mile) from Site B.

Step 2...
Take an Inclinometer reading in Degrees up to the Saddle.

You find the inclination is 15 Degs.

Step 3...
Convert "Degrees" into "Tangent."

15 Degs = .2679 (tangent look up table)

Step 4...
Determine the difference in altitude.

3,600 feet * .2679 = 964.44 feet

So the Saddle is 965 feet up, at 2/3rds of a mile out.

Step 5...
Determine the time it will take to get there.

5a) Calculate for the Horizontal element of hike.

Up Hill Rules =
1 Hour for every 2 miles (10,560 feet), plus (+),
1 Hour for every 400 ft gained in elevation.

(There are 5,280 feet in a mile.)

$$\text{Ratio: } \frac{10{,}560 \text{ feet}}{3{,}600 \text{ feet}} : \frac{60 \text{ minutes (1 hour)}}{? \text{ minutes}}$$

Show Work...
(3,600 feet * 60 = 216,000) / 10,560 feet = 20.45 Minutes
Horizontal

5b) Calculate for the Vertical up hill element of hike.

$$\text{Ratio: } \frac{400 \text{ ft}}{965 \text{ ft}} : \frac{60 \text{ min}}{? \text{ min}}$$

Show Work
(965 ft X 60 min = 57,900) / 400 ft = 144.75
minutes.

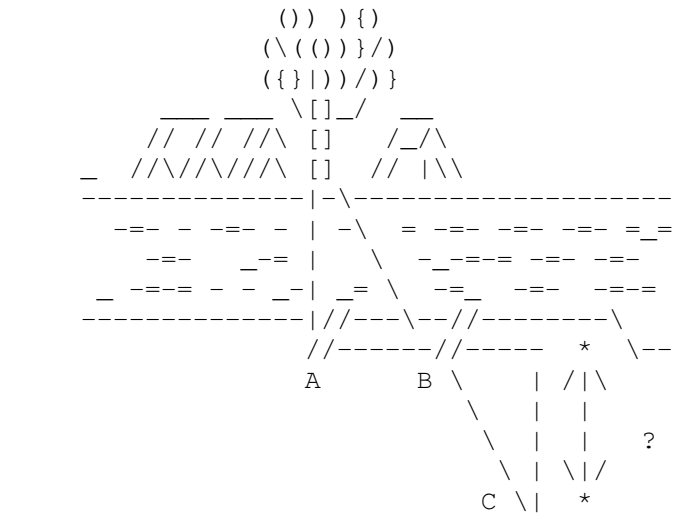
So we have...

```
  20.45 Minutes Horizontally
+144.75 Minutes Vertically
-------
 165.2  Minutes to get up the Switch-backs.
```

That's 2 hours and 45 minutes... Maybe you should wait till the morning to assault the Switch-backs.

HOW TO FIND THE WIDTH OF AN OBJECT.

An Object that can not be directly measured like a stream, lake, river, canyon or crevasse, can be measured indirectly using the compass.



Step 1...
Locate an object directly across from you on the other side to use as a reference. a tree, a rock, or an outcropping. Place a stick in the ground at your feet. (A)

Step 2...
Using the square Base Plate of the compass, turn 90 Degs away from the object. Walk a determined distance counted in paces, (5, 10, or 50) and then stop. Place another Stick in the ground. (B)

Step 3...
Continue walking in the same direction, the same number of paces again, and then stop.

Step 4...
Now turn 90 Degs (away from object), and walk counting an unknown number of paces looking over your shoulder at the Second Stick (B). When the Object and the Stick line up, the distance to the object is known.

Very Advanced:

Believe it or not, there IS a way to stay oriented without a map. It isn't going to show us where we might find water, decide a suitable route through the woods, or where to find a road... quite like a map can. However what it Can do is amazing! It works in the form of allowing you to tromp around the woods all-day, and then head straight back to camp, without needing to backtrack, or even a map.

It doesn't even require that the compass be True North or Magnetic North. All that it requires is the Vectors (in

degrees,) from our Azimuth Ring. This advanced technique can save your "resources." It does however, require a pencil, paper, and a calculator that can do sin, cos, and arc-tangent.

In this part of trigonometry, distance (r), has a relationship to degrees (Q). Using this relationship, we can make our way directly straight back to camp, no matter where we roam, or even if it's night or day. The secret is, that we need to keep an accurate written record of our (1.Distance and (2.Direction. Then, to find our way home, the last and final leg of the trip can be figured from anywhere! Even without a map!

===

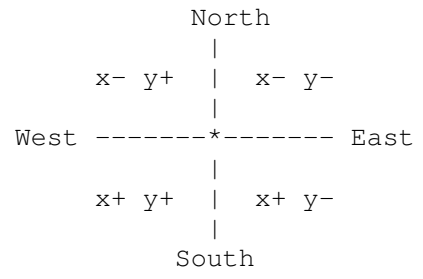
Our 4 Math-"magic" Rules For Polar Rectangular Coordinates:

$$x = r*(\cos*Q)$$

$$y = r*(\sin*Q)$$

$$Q = \text{Arctan}(y/x)$$

$$r = \sqrt{x^2 + y^2}$$

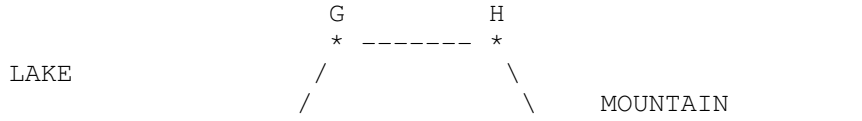


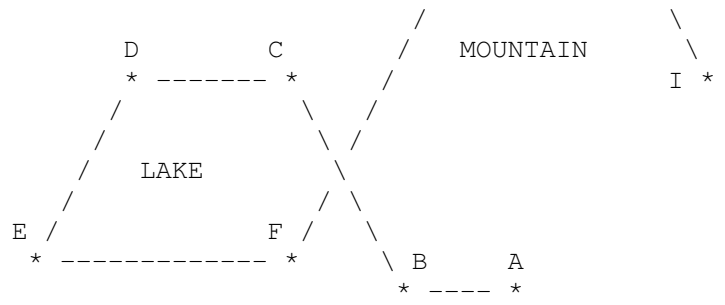
Q = Angle in Degrees r = distance from center of circle

===

Example 1:

Let's say we we're in our 4x4's, out in the middle of the desert. We could trek around all day with this method, and have a bearing for home when we decide to head back to camp, from any location on the map, or off.





As an example, let's say (A) is our Home Base, and we know of this great little dry lake bed 4 or 5 miles away, where our tire tracks wouldn't do the environment too much damage. So we get out the map, and sight along bearing 2-7-0 degrees, and write this down, along with our "start" odometer reading, and go. As we move around the desert, we intend to keep a log of all our milage/distances, and bearing directions, on this little paper. The chart's first entry would like this...

	Odometer Start	Odometer End	Elapsed r Miles	Q Degrees	x	y
A-B	<10,342.7>	?	?	<270>	?	?
B-C...						

When we arrive at the Dry Lake Bed, we enter our "end" odometer reading in the log:

	Odometer Start	Odometer End	Elapsed r Miles	Q Degrees	x	y
A-B	10,342.7	<10,344.45>	<1.75>	270	?	?
B-C...						

Then we take a bearing to our next location, and jot this down also...

	Odometer Start	Odometer End	Elapsed r Miles	Q Degrees	x	y
A-B	10,342.7	10,344.45	1.75	270	?	?
B-C	<10,346.0>	?	?	<328>	?	?
C-D...						

Each time we change bearings, we write down accurately, the distance covered, and new bearing. By the end of the day our log may look like this:

	Odometer Start	Odometer End	Elapsed r Miles	Q Degrees	x	y
A-B	10,342.7	10,344.45	1.75	270	?	?
B-C	10,346.0	10,349.5	3.5	328	?	?
C-D	10,346.5	10,352	2.5	270	?	?
D-E	10,352	10,355	3	212	?	?
E-F	10,355	10,359	4	90	?	?
F-G	10,359	10,364.5	5.5	33	?	?
G-H	10,364.5	10,367	2.5	90	?	?
H-I	10,367	10,369.5	2.5	152	?	?
I-A	?	?	?	?	?	?

Well, the gas tank is getting a bit low now, and we need to plot our way back to site (A)...

All we do is calculate for x and y:

When: x =r*(cos*Q) y =r*(sin*Q)

Then: Trail A-B.. x =1.75*(cos*270)= 0

y =1.75*(sin*270)= -1.75

And so forth, on down the list...

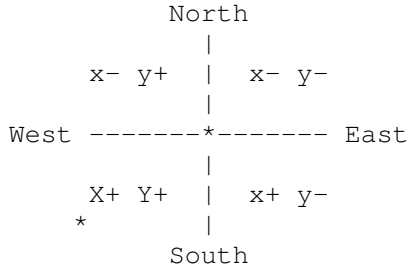
	Odometer Start	Odometer End	Elapsed r Miles	Q Degrees	x	y
A-B	10,342.7	10,344.45	1.75	270	< 0 >	<-1.75 >
B-C	10,346.0	10,349.5	3.5	328	< 2.968>	<-1.854>
C-D	10,346.5	10,352	2.5	270	< 0 >	< -2.5 >

D-E	10,352	10,355	3	212	<-2.544>	<-1.589>
E-F	10,355	10,359	4	90	< 0 >	< 4 >
F-G	10,359	10,364.5	5.5	33	< 4.612>	< 2.995>
G-H	10,364.5	10,367	2.5	90	< 0 >	< 2.5 >
H-I	10,367	10,369.5	2.5	152	<-2.207>	< 1.173>
I-A	?	?	?	?	?	?

To find the distance (r), and direction (Q), back to (A), from wherever we decide to stop (I), we simply add each column of x and y, and calculate our homeward bearing of (Q) degrees, at (r) distance.

	Odometer Start	Odometer End	Elapsed r Miles	Q Degrees	x	y
A-B	10,342.7	10,344.45	1.75	270	0	-1.75
B-C	10,346.0	10,349.5	3.5	328	2.968	-1.854
C-D	10,346.5	10,352	2.5	270	0	-2.5
D-E	10,352	10,355	3	212	-2.544	-1.589
E-F	10,355	10,359	4	90	0	4
F-G	10,359	10,364.5	5.5	33	4.612	2.995
G-H	10,364.5	10,367	2.5	90	0	2.5
H-I	10,367	10,369.5	2.5	152	-2.207	1.173
I-A	?	?	?	?	<2.829>	<4.725>

We can tell already by the positive polarity of x and y, that the general direction home is South West of us.



The next step is to figure for r and Q.

Where: Q =Arctan(y/x)

Then:

Step 1	Step 2	Step 3
Q =Arctan(4.725/2.829)	= Arctan(.598)	= 59.089 degrees

And again because x and y are positive, we already know home is South West of us. So we need to either add, or subtract, 180 or 360, to make the answer come out in the correct corner of the compass. In this case I'll add 180 degrees to the answer:

```
                Step 4
                59.089
               +189.
               ----------
Answer = 239.089 degrees
```

And Where: $r = \sqrt{x^2 + y^2}$

Then:

$$r = \sqrt{2.829^2 + 4.725^2} = \sqrt{8.003 + 22.325} =$$

Step 3

$$\sqrt{30.328} = 5.507 \text{ Miles}$$

Now we fill in the blanks on our chart:

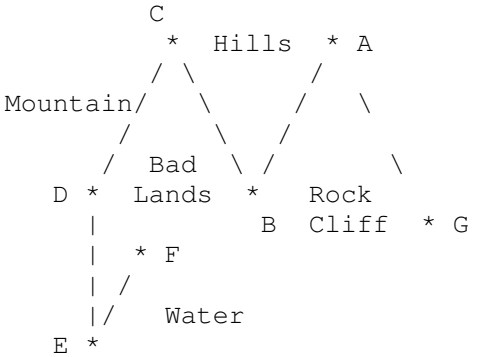
	Odometer Start	Odometer End	Elapsed r Miles	Q Degrees	x	y
A-B	10,342.7	10,344.45	1.75	270	0	-1.75
B-C	10,346.0	10,349.5	3.5	328	2.968	-1.854
C-D	10,346.5	10,352	2.5	270	0	-2.5
D-E	10,352	10,355	3	212	-2.544	-1.589
E-F	10,355	10,359	4	90	0	4
F-G	10,359	10,364.5	5.5	33	4.612	2.995
G-H	10,364.5	10,367	2.5	90	0	2.5
H-I	10,367	10,369.5	2.5	152	-2.207	1.173
I-A	10,369.5	10,375	<5.5>	<239.08>	2.829	4.725

So the direction for home (I-A), could be calculated in 5 minutes, and home is just 5.5 miles away, instead of backtracking 23.

From this chart we can figure that we will travel 5.5 miles, at bearing 239, and, when our odometer clicks over to 10,369.5, we should be back at base camp, refueling.

The 5 or 7 minutes of calculation, has saved us about 1 hour of backtracking (at 20 mph).

Example 2:



Here we are at Home Base (A), and our eventual destination is going to be downhill at site (G). However, we have to pick up some water about 2/3rds of a mile away first, and backtracking uphill will be inconvenient. In the process of getting water, we have to circumnavigate several other natural barriers too.

Our first step will be to shoot a bearing over to (G), and then find (G) on the map. Let's say the bearing is 1-4-8 degs. The map says its about 1500 feet away, 1/4 of a mile, or about 300 paces.

$$\text{Ratio} : \frac{100 \text{ feet}}{20 \text{ Paces}} : \frac{1500 \text{ feet}}{?} = (20 * 1500)/100 = 300 \text{ Paces}$$

We write this information down on our paper. r = 300 Paces (G-A).

We also write down the bearing from (A-G) as a "Back Bearing" (G-A), on our paper.

148 degs forward = 148+180 = 328 degs back

	r Paces	Q degrees	x	y
G-A	<300>	<328>	?	?
A-B.....				

	r Paces	Q degrees	x	y

Next, we shoot a bearing to (B), our first intermediary destination. We read on the compass, 212 degrees, and we write this down.

	r Paces	Q degrees	x	y

	r Paces	Q degrees	x	y
G-A	300	328	?	?
A-B	?	<212>	?	?
B-C....				

As we walk to (B), we count every right footstep (Pace). When we get to (B), we find that we have covered about 250 paces. So we write this down also.

	r Paces	Q degrees	x	y
G-A	300	328	?	?
A-B	<250>	212	?	?
B-C...				

Then we shoot-and-write our next bearing to (C).

On every leg of the journey, we jot down each change in direction, and each distance covered. When we finally, get to the water, and fill our canteens at (F), our paper looks like this:

	r Paces	Q degrees	x	y
G-A	300	328	?	?
A-B	250	212	?	?
B-C	250	328	?	?
C-D	250	212	?	?
D-E	200	180	?	?
E-F	150	32	?	?
F-G	?	?	?	?

Now we can calculate a straight line route to site (G) from our present location. (We may or may not need to circumnavigate around to site (G), but we already learned how to do this... Right?)

First we figure for x and y.

Where: x =r*(cos*Q) y =r*(sin*Q)

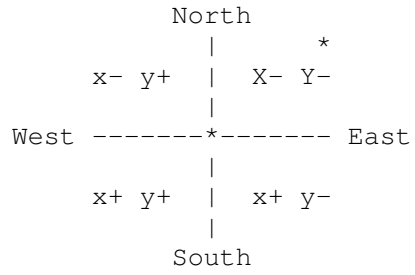
	r Paces	Q degrees	x	y
G-A	300	328	< 254.41 >	<-158.975>
A-B	250	212	<-212.012>	<-132.479>
B-C	250	328	< 212.012>	<-132.479>

	r Paces	Q degrees	x	y
C-D	250	212	<-212.012>	<-132.479>
D-E	200	180	<-200 >	< 0 >
E-F	150	32	< 127.207>	< 79.487>
F-G	?	?	?	?

Then we add the columns of x and y...

	r Paces	Q degrees	x	y
G-A	300	328	254.41	-158.975
A-B	250	212	-212.012	-132.479
B-C	250	328	212.012	-132.479
C-D	250	212	-212.012	-132.479
D-E	200	180	-200	0
E-F	150	32	127.207	79.487
F-G	?	?	<-30.395>	<-476.925>

From the polarity of x and y we can tell that our new direction to (G) is going to be in a North Easterly direction.



Now we can calculate for Q degrees, and r distance:

When: Q =Arctan(y/x)

Then:

Q =Arctan(-476.925/-30.395) = Arctan(15.69) = 86.353 degrees

Now, because both x and y are negative, and falls between 0 and 90 degrees, the number is correct as is.

And Where:

$$r = \sqrt{x^2 + y^2}$$

Then:

$$r = \sqrt{-30.395^2 + -476.925^2} = \sqrt{923.856 + 227457.46} =$$

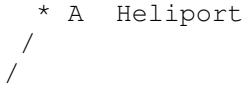
$$\sqrt{228381.31} = 477.89 \text{ Paces}$$

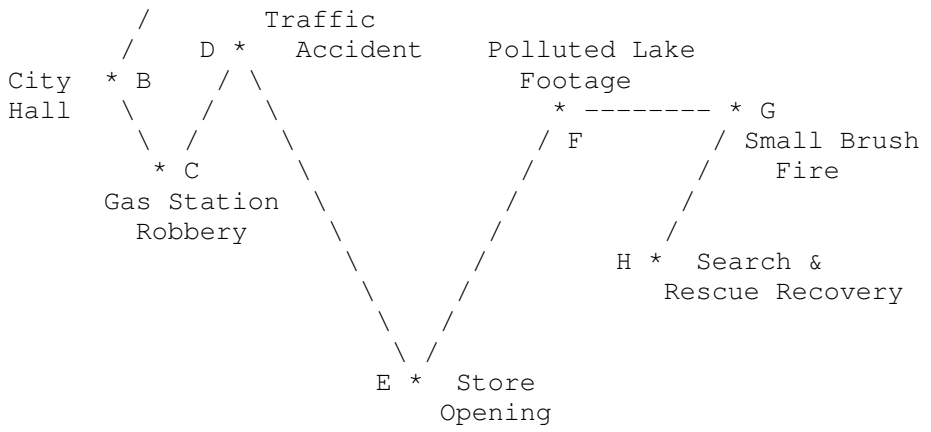
So the completed chart looks like:

	r Paces	Q degrees	x	y
G-A	300	328	254.41	-158.975
A-B	250	212	-212.012	-132.479
B-C	250	328	212.012	-132.479
C-D	250	212	-212.012	-132.479
D-E	200	180	-200	0
E-F	150	32	127.207	79.487
F-G	<477.89>	<86.3>	-30.395	-476.925

In this way we find out that by heading bearing mark 86 degrees for 478 Paces, we should be standing on site (G).

Example 3:





Let's use an example of a News Helicopter, flying around your home town. Let's say he can cover the ground at a fairly constant rate of about 70 mph on a good day. As he travels from scene to scene, he'll buzz around in the target area for awhile till he decides to leave for another News breaking story. He may spend 10, 20, or 30 minutes at each location before moving on. Now pilots log everything anyway, so keeping a Distance/Direction chart is just a part of being a pilot. Truck drivers too for that matter. By writing down the times he arrives and departs, along with the direction he heads off in, he'll be able to plot a straight line course back to the heliport at the end of his long day.

Let's say at 8am he leaves the heliport on bearing 212 degrees, and heads Downtown to cover a speech by the mayor. He writes this down.

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A-B	<8am>	?	?	?	<212>	?	?
B-C....							

When he arrives, he jots down the time of arrival.

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A-B	8am	<9am>	?	?	212	?	?
B-C....							

This is an elapsed time of 1 hour, or 60 minutes which is also plotted.

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A–B	8am	9am	<1h>	<60>	?	?	?
B–C....							

15 minutes later, he hears on his police scanner, that a Gas Station he knows of, has a "robbery in progress." So he gets out his map, and takes a bearing of 148 degrees. Plots it, and his time, and heads straight for the scene of the crime.

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A–B	8am	9am	1h	60	212	?	?
B–C	<9:15>	?	?	?	<148>	?	?
C–D...							

When he arrives, he then plots his arrival time, and elapsed time.

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A–B	8am	9am	1h	60	212	?	?
B–C	9:15	<9:45>	<34m>	<34>	148	?	?
C–D...							

And so on all through the day... At the end of the day his log would look like this:

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A-B	8am	9am	1h	60	212	?	?
B-C	9:15	9:45	34m	34	148	?	?
C-D	10:02	10:58	56m	56	32	?	?
D-E	11:10	13:18	2h15m	135	148	?	?
E-F	13:25	15:00	1h45m	105	32	?	?
F-G	15:15	16:19	1h4m	64	90	?	?
G-H	16:35	17:35	1h	60	212	?	?
H-A	?	?	?	?	?	?	?

When the News pilot reaches the end of his day, and he wants to head straight home, he'll figure his chart for x and y:

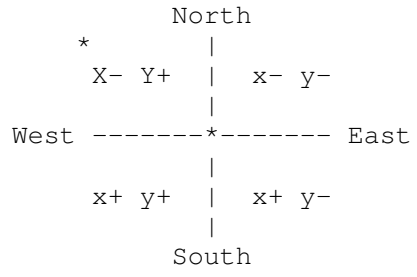
Where: x =r*(cos*Q) y =r*(sin*Q)

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A-B	8am	9am	1h	60	212	< -50.882>	<-31.795>
B-C	9:15	9:45	34m	34	148	< -28.833>	< 18.017>
C-D	10:02	10:58	56m	56	32	< 47.49 >	< 29.675>
D-E	11:10	13:18	2h15m	135	148	<-114.486>	< 71.539>
E-F	13:25	15:00	1h45m	105	32	< 89.045>	< 55.641>
F-G	15:15	16:19	1h4m	64	90	< 0 >	< 64 >
G-H	16:35	17:35	1h	60	212	< -50.882>	<-31.795>
H-A	?	?	?	?	?	?	?

Then the x and y columns are totaled.

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A-B	8am	9am	1h	60	212	-50.882	-31.795
B-C	9:15	9:45	34m	34	148	-28.833	18.017
C-D	10:02	10:58	56m	56	32	47.49	29.675
D-E	11:10	13:18	2h15m	135	148	-114.486	71.539
E-F	13:25	15:00	1h45m	105	32	89.045	55.641
F-G	15:15	16:19	1h4m	64	90	0	64
G-H	16:35	17:35	1h	60	212	-50.882	-31.795
H-A	?	?	?	?	?	<-108.548>	<175.282>

He can tell from the polarity of x and y that home is North West.



Then he will calculate for Q degrees, and r time:

When: Q =Arctan(y/x)

Then...

Q= Arctan(175.282/-108.548) = Arctan(-1.614) = -58.231

Now because x is negative, and y is positive, he will need to add or subtract 180 or 360 to get the correct answer for that corner of the compass.

-58.231
+360.

Answer 301.76 Q degrees

And When:

$$r = \sqrt{x^2 + y^2}$$

Then....

$$r = \sqrt{-108.548^2 + 175.282^2} = \sqrt{11782.668 + 30723.78} =$$

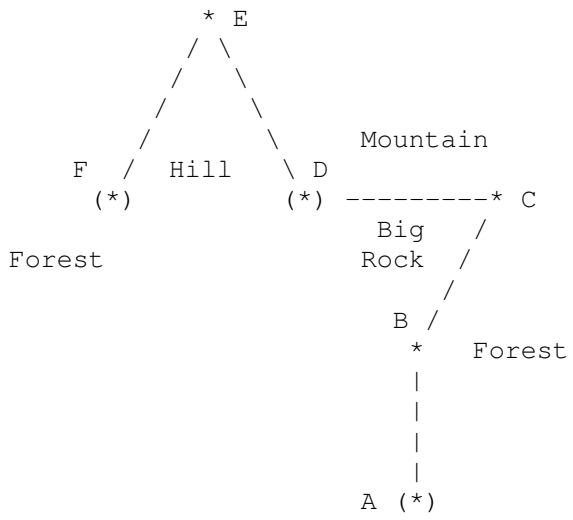
$$\sqrt{42506.448} = 206.17 \text{ Minutes}$$

So his completed chart would look like:

	Start Time	Stop Time	Elapsed Time	Elapsed Time In r Minutes	Q degrees	x	y
A-B	8am	9am	1h	60	212	-50.882	-31.795
B-C	9:15	9:45	34m	34	148	-28.833	18.017
C-D	10:02	10:58	56m	56	32	47.49	29.675
D-E	11:10	13:18	2h15m	135	148	-114.486	71.539
E-F	13:25	15:00	1h45m	105	32	89.045	55.641
F-G	15:15	16:19	1h4m	64	90	0	64
G-H	16:35	17:35	1h	60	212	-50.882	-31.795
H-A	18:00	21:26	3h26m	<206.17>	<301.76>	-108.548	175.282

So the pilot knows his estimated time of arrival is in 206 minutes, or 3 hours, and 26 minutes, on bearing 301 degs. That means he'll arrive at the heliport sometime around 9:26 at night.... Another long day...

Example 4:



In this example, let's say my Troop is camping in spread-out Low Impact sites, at several locations this evening, (A) (D) & (F). If a buddy and I wish to go visiting this afternoon, we'll remain safest if we keep track of our locations as we go. That way we can find our way back in the dark if need be.

As we head out on bearing A-B, my buddy shoots the angle with his compass and finds that it is due north. This is marked on his paper...

	r Yards	Q degrees	x	y
A-B	?	<0>	?	?
B-C....				

As we get to point (B), we mark how far we have traveled on line (A-B). Say we traveled 200 yards to point (B).

	r Yards	Q degrees	x	y
A-B	<200>	0	?	?
B-C...				

And at the same time we shoot a new bearing to point (C), which happens to be circumnavigating around "Big Rock" outcropping. The compass Bearing is 32 degrees. We write this down too.

	r Yards	Q degrees	x	y
A-B	200	0	?	?
B-C	?	<32>	?	?
C-D	....			

Every time we change direction we, write down how far we came and the new bearing to the next landmark. By the time we make it to camp (F), our chart looks like:

	r Yards	Q degrees	x	y
A-B	200	0	?	?
B-C	250	32	?	?
C-D	300	270	?	?
D-E	300	328	?	?
E-F	300	212	?	?
F-A	?	?	?	?

At camp (F) we take a moment and calculate our way back to our own tent site (A). First we figure for x and y :

Where: x =r*(cos*Q) y =r*(sin*Q)

	r Yards	Q degrees	x	y
A-B	200	0	< 200 >	< 0 >
B-C	250	32	< 212.012>	< 132.479 >
C-D	300	270	< 0 >	<-300 >
D-E	300	328	< 254.414>	<-158.975 >
E-F	300	212	<-254.414>	<-158.975 >
F-A	?	?	?	?

Then the x and y columns are totaled.

	r Yards	Q degrees	x	y
A-B	200	0	200	0
B-C	250	32	212.012	132.479
C-D	300	270	0	-300
D-E	300	328	254.414	-158.975
E-F	300	212	-254.414	-158.975
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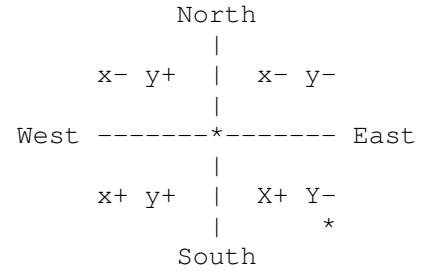
F-A	?	?	<412.012>	<-485.471>

I can tell right off the bat,,that the direction we will be traveling in is going to be in a South Easterly direction, because of the polarity of x and y.



Then I calculate for Q degrees, and r distance:

Where: Q = Arctan(y/x)

Then...

Q= Arctan(-485.471/412.012) = Arctan(-1.1782) = -49.679 degrees

Now because x is positive, and y is negative, I need to add or subtract 180 or 360 to get the correct answer for that corner of the compass.

```
 -49.679
+180.
--------
```

Answer 130.32 Q degrees

And Where:

$$r = \sqrt{x^2 + y^2}$$

Then....

$$r = \sqrt{412.012 + -485.471} = \sqrt{169753.89 + 235682.09} =$$

$$\sqrt{405435.98} = 636.73 \text{ yards}$$

So the completed chart looks like:

	Yards	Q degrees	x	y
A-B	200	0	200	0
B-C	250	32	212.012	132.479
C-D	300	270	0	-300
D-E	300	328	254.414	-158.975
E-F	300	212	-254.414	-158.975
F-A	<636.7>	<130.32>	412.012	-485.471

And we know that if we walk 640 yards at 130 degrees, well be able to sleep in our own tent.

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□