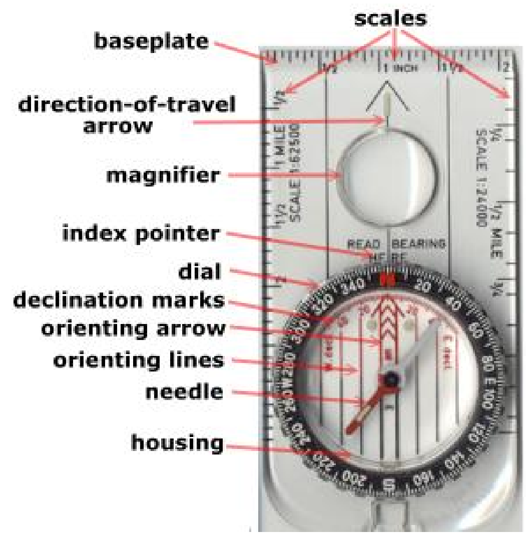
Your Compass | A Helpful Resource

A compass is an extremely valuable piece of equipment used not only by hikers and campers, but also pilots in airplanes, captains of ships and car drivers everywhere. It is such a simple but powerful item; everyone should know how to use one.

Wherever you happen to be on Earth, a compass in your hand will, always point North. Whether you are stranded in the ocean, caught in a blizzard or lost in a deep, dark forest late at night, your friend the compass will never let you down and can always be used to help find the way. Sure, a GPS is pretty cool, but it needs batteries and a signal, not the magnetic compass!

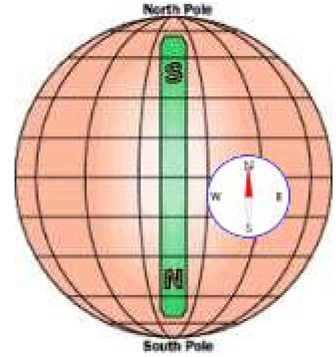
You're on your way to learning how to use a compass.

Parts of a Compass
There are many types of compasses ranging from tiny thumb compasses to complex high-tech gadgets. For most hikers and outdoors people, an orienteering compass works just great and that is what we'll discuss here.



Not all compasses include each of these parts and some compasses include even more.	
Baseplate	Hard, flat surface on which the rest of the compass is mounted. It has rulers on its edges for measuring distances on maps. Its edge is straight and useful for laying lines on a map.
Scales	Each edge of a compass may have different rulers for use with different map scales.
Direction-of-Travel Arrow	Marked on the base plate. You point this the way you will be travelling.
Magnifier	For seeing small map features better.
Index Pointer	Butt end of the direction-of-travel arrow. It ends right at the edge of the dial and is where you take degree readings from.
Dial	Ring around the housing that has degree markings engraved. You hold the dial and rotate it to rotate the entire housing.
Declination Marks	Use to orient the compass in an area with known declination.
Orienting Arrow	Marked on the floor of the housing, it rotates with the housing when the dial is turned. You use it to orient a compass to a map.
Orienting Lines	A series of parallel lines marked on the floor of the housing and on the base plate.
Needle	A magnetized piece of metal that has one end painted red to indicate North. It sits on a fine point that is nearly frictionless so it rotates freely when the compass is held fairly level and steady.
Housing	The main part of the compass. It is a round plastic container filled with liquid and has the compass needle inside.
Bubble	A bubble of air in the housing liquid is useful for making sure you are holding the compass fairly level.
Mirror	Lets you see the compass face and distant objects at the same time. Useful for emergency signalling.
Sight	Improves aiming your compass at distant objects.

How a Compass Works



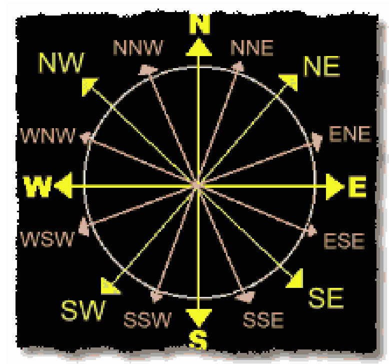
There is a huge magnetic field around the earth. It is huge, but it is not very strong. The magnetized needle in a compass is aligned with this magnetic field. As this image shows, the composition of the earth acts as a huge bar magnet sitting upside down in the middle of the planet. Since its South end is at the north pole and its North end is at the south pole, the North end of a compass needle is pulled north.

Your compass has to have a very light needle sitting on a pivot that has almost no friction. This is because the earth's magnetic field is weak and would not be able to turn the needle.

Reading a Compass | General Directions

A compass can be used in many ways, from telling which way is North to finding hidden treasure or following an unmarked path over wilderness terrain. But, you've got to take baby steps, so let's talk about how a compass is laid out.

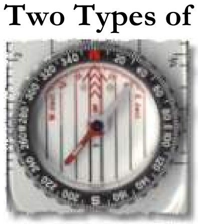
There are four **cardinal points** on a compass - North, South, East and West. When reading a compass and telling other people directions, you need to wipe "right" and "left" out of your vocabulary. Right and Left are relative directions and differ depending on your location and direction, but the cardinal points are constant.



The direction halfway between North and East is an **intercardinal point** and is called *NorthEast*. The other three intercardinal points are *SouthEast*, *SouthWest* and *NorthWest*. Finally, there are **secondary intercardinal points** halfway between each cardinal point and intercardinal point. These are *North-NorthEast*, *East-NorthEast*, *East-SouthEast*, *South-SouthEast*, and so on. With these directions, you can give someone a fairly good idea of what direction they need to go.

Since there is a need for more precise directions, the circle of a compass face is split into 360 marks called **degrees**. For rough directions, go ahead and use North or *NorthWest*, but, for finding your way or locating destinations in the wild, use **degrees** as you'll see in a bit.

Two Types of Compasses



We will be discussing the **mountaineering** compass, also called the **orienteering** compass. This is the type that has a needle that always points north and you need to move a dial to find directions.

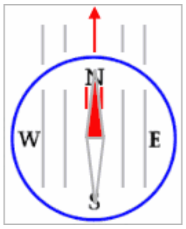
You may have seen compasses in cars or boats, but neither of these has a noticeable needle. They are called **card compasses**. Although there is no needle, per se, there is magnetic material that has a paper disk (card) glued to it or a plastic ball around it. This allows it to rotate as the vehicle turns. These are fine for general directions, but not helpful for what we want to do.

Basic Compass Reading

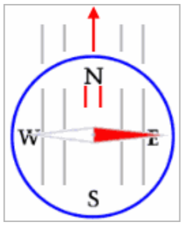
No matter the compass, one end of the needle always points North. On our mountaineering compasses, it is *almost always* the **RED** end, but it's a good idea to test your compass before starting to use it. If you are north of the equator, stand facing the sun around lunchtime. Whichever end of the needle points towards the sun is South and the end that points at you is North. If you're in Australia, the North end points towards the sun and the South end points at you.

To read your compass,

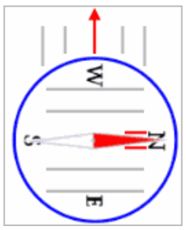
- ✓ Hold your compass steadily in your hand so the baseplate is level and the direction-of-travel arrow is pointing straight away from you.
- ✓ Hold it about halfway between your face and waist in a comfortable arm position with your elbow bent and compass held close to your stomach.
- ✓ Look down at the compass and see where the needle points.



This compass is pointing due North (0˚)
- ✓ Turn your body while keeping the compass right in front of you.
- ✓ Notice that as the compass rotates, the needle stays pointing the same direction.
- ✓ Keep turning until the needle points East like the picture below, keeping the direction-of-travel arrow and North mark facing straight in front of you.



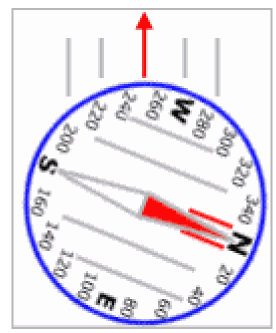
This compass is pointing East (90˚)
Important: This is a very common mistake! The compass needle is pointing towards East, so I must be pointing East, right? No, no, no!
To find my direction, I must turn the compass dial until the North mark and the Orienting Arrow are lined up with the North end of the needle. Then, I can read the heading that is at the Index Pointer spot *(the butt of the direction-of-travel arrow)*.



Since the Orienting Arrow is usually two parallel lines on the floor of the compass housing, a good thing to memorize is: **RED IN THE SHED**

Now we know we are really heading West (270˚)

Take a Bearing
By simply moving your compass with your body and using the N-E-S-W markings, you can get a good idea which way you are going. This is often all you need from your compass. But, you've probably noticed on your compass, there are also numbers and tiny lines. These represent the 360˚ in a circle that surrounds you no matter where you are.



When you need to find your way from one particular place to another, you need to use these numbers to find out the **bearing** to that remote place. The direction you are going is called your **heading**. Heading and Bearing are pretty much the same thing. This image is a heading of about 250˚.

Using your compass, take a few bearings. Move your body until the direction-of-travel arrow points at the following items and then turn the dial until **RED is in the Shed**. Now read the bearing at the Index Pointer:
- ✓ Your computer screen: ____________ ˚
- ✓ Your window: ____________ ˚
- ✓ Your door: ____________ ˚
- ✓ A light switch: ____________ ˚

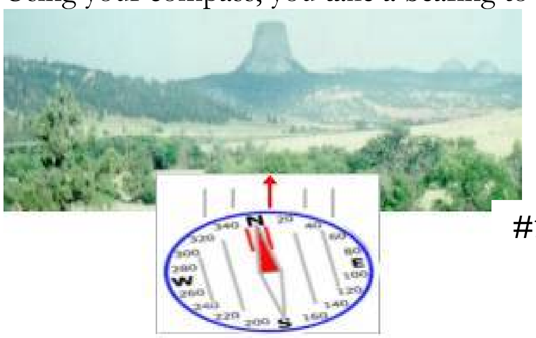
Compass Reading Tips
- ✓ Hold the compass level - if the compass is tilted, the needle will touch the clear lid and not move correctly.
- ✓ Read the correct end of the needle.
- ✓ Use common sense, such as knowing that if you are heading anywhere towards the sun, there's no way you can be heading north, northwest or northeast.
- ✓ **RED IN THE SHED!**
- ✓ Keep the compass away from metal objects - even a knife, flashlight or keychain can cause a false reading if too close to the compass.

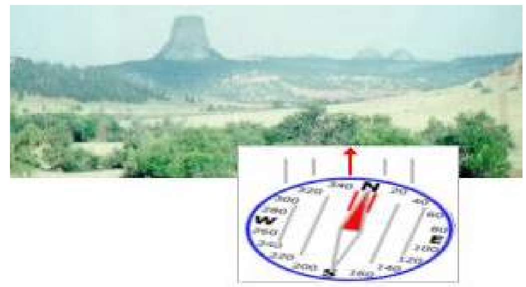
Using a Compass | Main Compass Uses
The main functions of using a compass are:
- ✓ tell which direction you are travelling - your heading
- ✓ tell which direction an object is from you - its bearing
- ✓ keep you following a straight line of travel
- ✓ orient a map - aligning a map with the actual land

- ✓ triangulation - determining your location with a map
- ✓ plan routes - determine directions and distances to travel on a map

We've already discussed an important skill in how to use a compass and that is determining your **heading**. Point the direction-of-travel arrow straight ahead in the direction you are going, turn the compass dial until **RED is in the Shed**, and read the heading at the Index Pointer. Determining the **bearing** to an object is just like finding your heading. Turn to face the object and do the steps for determining your heading.

Here's a simple exercise to try...
On a hike, you see a strange rock formation off in the distance.
Using your compass, you take a bearing to it as shown below:





#1

If you turn and face two smaller rock formations further off in the distance, which of the following bearings would be correct?

In this case, since you are facing northerly, a turn to the right will be more to the East so **#1 is correct**. It is important to keep a feel for general directions in your mind. If the sun is at your back, you are heading northerly. If its early morning and the sun is in your face, you are heading east with north on your left and south on your right. Remember, right and left are relative to your current heading.

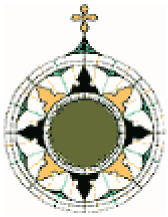
#2

Learning how to use a compass to **follow a line of travel** is simply pausing to take a reading occasionally while hiking. In the picture below, you're trying to find your way to the lake in the distance to refill your water supply.

In this opening in the forest, you pause to take a bearing to the lake and see that it is about 220 degrees.
Ahead of you, there is no trail and you drop into thick forest. You won't be able to see the lake or easy landmarks for quite awhile.
As you walk, you need to occasionally check your heading on the compass to ensure you are still heading 220 degrees.
You now understand how to use a compass to read your current heading and to take a bearing to a distance landmark. Using a compass in this way will guide you over terrain that you are acquainted with or if you know the general directions you need to travel before hand. But, for new territory, you will also need to know how to read maps and use a compass to guide your way.

Map Skills

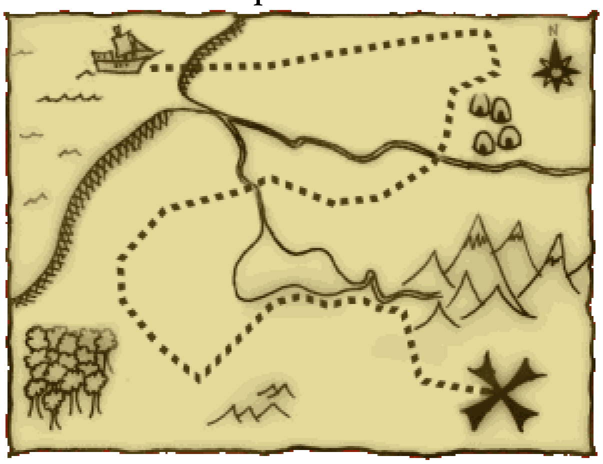
A compass without a map for reference is only half the challenge. Keeping a detailed map in your side pocket and knowing how to read it correctly will complete your wilderness navigation toolkit.



As kids, my friends and I hid treasure in the woods and then made maps and used compasses to find it. It was great fun to walk to the big apple tree, walk 50 steps east, then 125 steps south to the big rock, then 25 steps west and look for an **X** on the ground. Of course, we need a bit more detail than that out in the real world, but much of the skills are the same.

Map reading is a satisfying experience. When you use your imagination to picture what the map is representing, the mountains and rivers can come alive even before you actually walk them. Once you understand a compass and can read a map, you can then use a map and compass together efficiently.

How to Read a Map



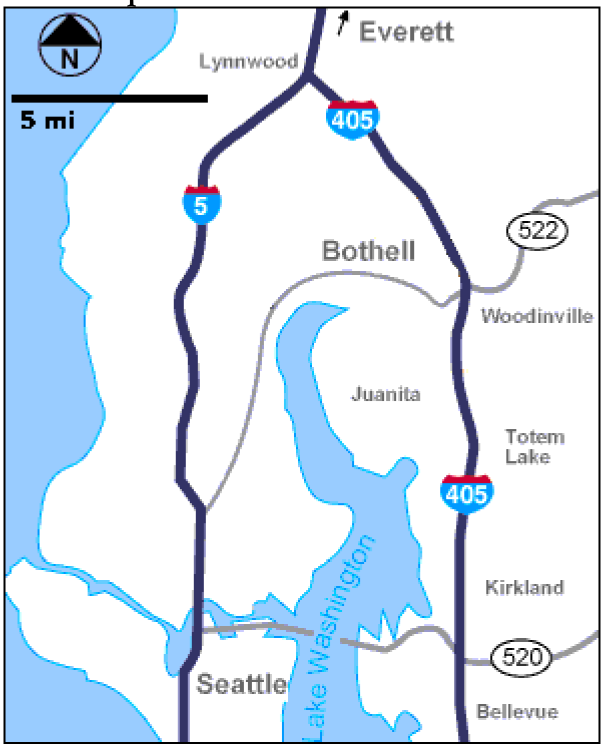
Whether a charcoal and parchment treasure map or multi-colored, plastic-coated, trail map, maps tell a story of the world around us. Maps help us to locate places, measure distances, and find where we are on the earth.

Reading maps is not usually difficult because there are some rules that are generally followed when creating and reading maps:

- North, South, East, and West are the four main "cardinal" directions.
- On a map, North is at the top, South at the bottom, West to the left, and East to the right.
- Every map has a *Map Scale* which relates distance on the map to the world. For example, one inch equals one mile.
- Using the scale of a map, you can tell the actual distance between two points for real.
- Maps use *map symbols* to represent real-world things, such as buildings, trails, roads, bridges, and rivers.
- Maps use colors to share more information. Blue often means water, green means forest, and white means bare land.
- A map has a *Legend* which lists the symbols it uses and what they mean.
- A grid of imaginary lines wrap around and over the earth. These lines are called *Latitude* and *Longitude* and can identify the exact location of any point on earth.

Keeping those things in mind, you can read pretty much any map and especially learn how to read a topographic or topo map for navigation in the back country.
Here are some exercises to help you learn how to read a map:

- **Basic Map Parts**

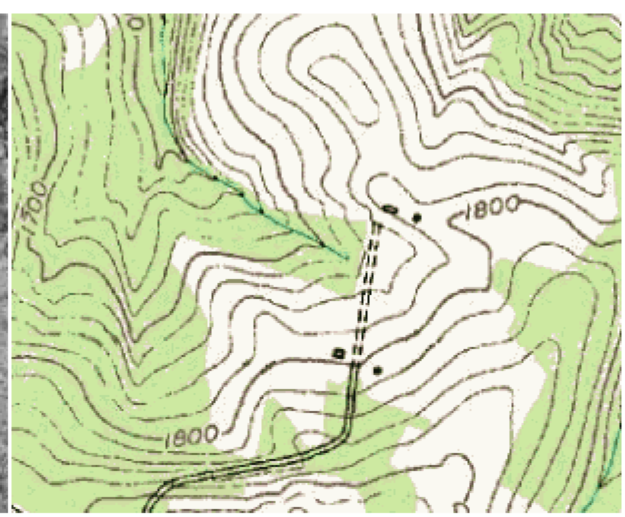


This simple road direction map contains a lot of information:

  - North is marked in the upper-left corner so you know which way this map relates to the world.
  - The Scale is marked. One inch equals 5 miles, so you can tell it is about 15 miles from Seattle to Woodinville.
  - Main roads are included so you can find the best route direction between two locations.
  - Roads are labeled so you know what to look for when navigating.
  - Bodies of water are colored blue.

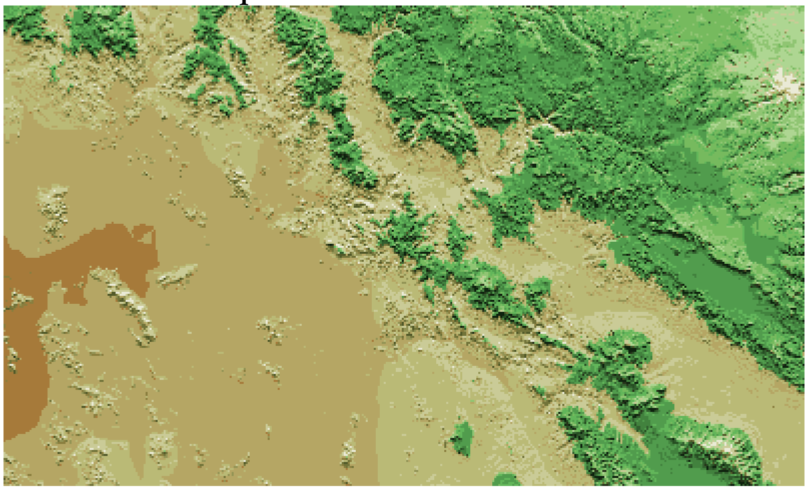
So, you can see even a simple road map is packed with good direction and navigation information. The maps we use for hiking are even more packed with details.

- **Maps or Photos**

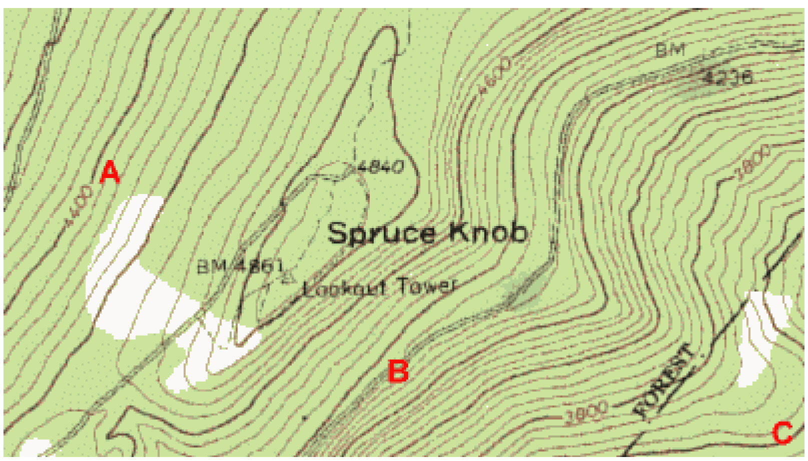
The topo map on the right represents the land in the aerial photo on the left. Notice the buildings and roads on the map can be seen in the photo. Move your mouse over the photo to see the objects highlighted.
A navigation map is actually more useful than a photograph since it can highlight important items and ignore clutter like trees and shadows.

- **Shaded Relief Maps**



Adding shading to denote shadows thrown by the sun and colors to denote elevation change, beautiful and somewhat realistic maps can be created. The example above shows a high mountain in white in the NorthEast (upper-right) with elevation dropping to a low, flat plain in the SouthWest (lower-left). Mountains, ridges, cliffs, canyons, and plateaus can all be identified.
Shaded relief adds depth and interest to a map, but more is needed to make a map truly useful to us hikers and explorers for navigating wild areas.

- **Contour Lines**



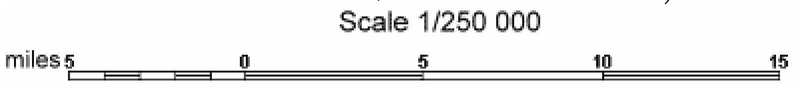
Contour lines are extremely important for outdoors dudes so you know what to expect a mile ahead on the trail. Contour lines show the elevation changes of the terrain. These are called *Topographic Maps* because they show the topography of the land.
In this example, the elevation at the spot marked **A** is about 4400 feet above sea level as indicated on the contour line close to it.
The elevation of **B** is a bit more difficult to figure out, but if you look closely, you might figure out that it is about 4350 feet. We have a page all about topographic maps coming up.

Map Scale

Any scale can be used for a map, but a few common scales have been settled on for use by most organizations:

- 1:24,000 - primary scaled used by USGS for mapping the United States in topographic form. 1 inch on the map equals 24000 inches in the real world, which is the same as 2,000 feet. This scale is used on the over 54,000 quadrangle maps covering the entire country. They are also called *7.5 minute quadrangles* because the area covered by one map is 7.5 minutes of latitude high by 7.5 minutes of longitude wide on paper that is about 29 inches high and 22 inches wide.
- 1:63,360 - 1 inch equals 1 mile
- 1:50,000
- 1:250,000
- 1:1,000,000

The smaller the number on the bottom of the map scale, the more detailed the map will be. A 1:10,000 map will show objects ten times as large as a 1:100,000 map but will only show 1/10th the land area on the same sized piece of paper. Here is an example of a Bar Scale found on a map. The scale shows that about 1.25 inches equals 5 miles. The smaller increments to the left of zero are each 1 mile and are used to estimate smaller distances. Notice the scale is 1/250000 - that means 1 inch on the map is equal to 250,000 inches on the real land. (5 miles = 5*5280 feet = 5*5280*12 inches = 316800 inches. 316800 inches / 250000 = 1.27 inches)



By including a map scale like the image above, if the map is photocopied and reduced in size, the scale can still be used. Otherwise, 1 inch would no longer equal what it should.

Calculating the Map Scale:

$$\frac{\text{Distance on Map}}{\text{Distance on Ground}} == \frac{1.27 \text{ inches}}{5 \text{ miles}} = \frac{1.27 \text{ inches}}{316800 \text{ inches}} == \frac{1}{250000}$$

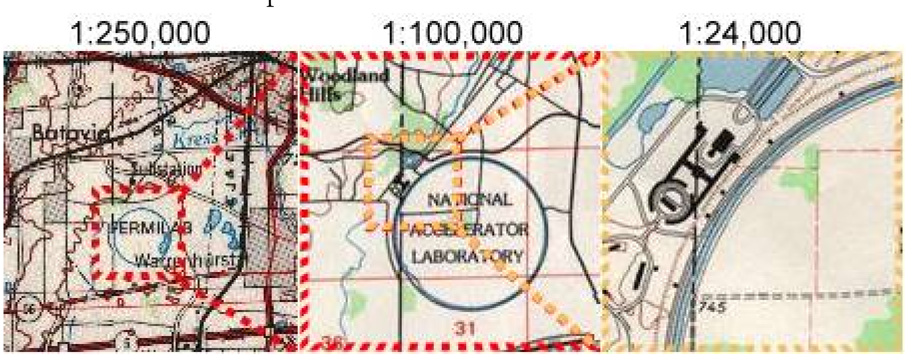
Maps are considered **large scale maps** or **small scale maps**. A large scale map shows greater detail because the scale is a larger fraction than a small scale map.

Large scale maps have a scale of 1:50,000 or greater (1:24,000, 1:10,000, ...).

Maps with scales from 1:50,000 to 1:250,000 are considered intermediate.

Small scale maps are those with scales smaller than 1:250,000. A map of the world that fits on two pages of letter sized paper would be very small scale with a scale of around 1:100,00,000.

Here are 3 views of the same location on maps with different scales:



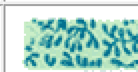
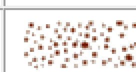
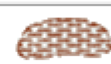
Map Symbols

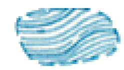
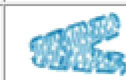
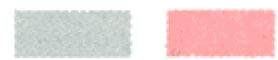
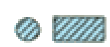
Since a map is a reduced representation of the real world, map symbols are used to represent real objects. Without symbols, we wouldn't have maps.

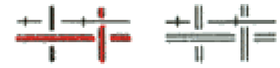
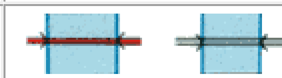
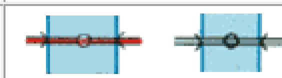
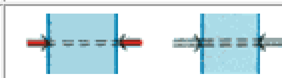
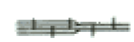
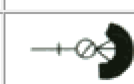
Both *shapes* and *colors* can be used for symbols on maps. A small circle may mean a point of interest, with a brown circle meaning recreation, red circle meaning services, and green circle meaning rest stop. Colors may cover larger areas of a map, such as green representing forested land and blue representing waterways.

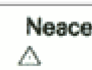
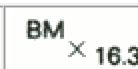
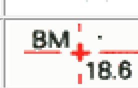
To ensure that a person can correctly read a map, a *Map Legend* is a key to all the symbols used on a map. It is like a dictionary so you can understand the meaning of what the map represents.

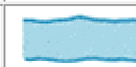
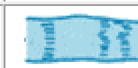
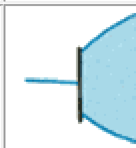
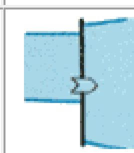
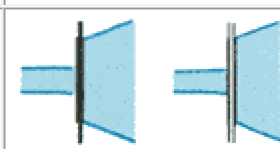
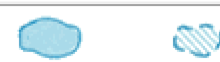
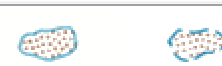
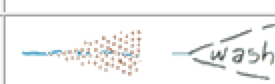
Here are some common symbols:

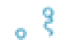
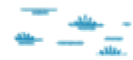
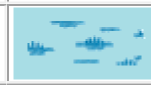
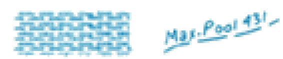
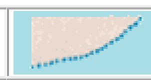
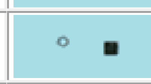
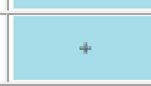
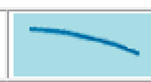
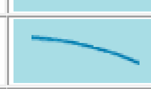
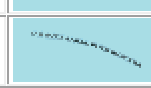
TOPOGRAPHIC CONTOURS (land elevation)	
Index number written on line	
Intermediate between Index lines	
Supplementary added to flat areas to show measurements	
Depression such as volcano top or crater (little dashes are called *hachures*)	
Cut; Fill roadway leveling terrain	
VEGETATION	
Woodland trees at least 6feet tall	
Scrub low brush	
Orchard planted vegetation	
Vineyard cultivated vines	
Mangrove dense, tropical trees	
SURFACE FEATURES	
Levee	
Sand or mud area, dunes or shifting sand	
Intricate surface area	
Gravel beach or glacial moraine	
Tailings pond	
MINES AND CAVES	
Quarry or open pit mine	
Gravel, sand, clay, or borrow pit	
Mine tunnel or cave entrance	
Prospect; mine shaft	
Mine dump	

Mine tailings	
GLACIERS AND PERMANENT SNOWFIELDS	
Limit blue denotes coverage	
Form lines Show shape, not elevation	
BUILDINGS AND RELATED FEATURES	
Building	
School; church	
Built-up Area	
Racetrack	
Airport	
Landing strip	
Well (other than water); windmill	
Tanks	
Covered reservoir	
Gaging station	
Landmark object (feature as labeled)	
Campground; picnic area	
Cemetery: small; large	
ROADS AND RELATED FEATURES	
Primary highway	
Secondary highway	
Light duty road	
Unimproved road	
Trail	

Dual highway	
Dual highway with median strip	
Road under construction	
Underpass; overpass	
Bridge	
Drawbridge	
Tunnel	
RAILROADS AND RELATED FEATURES	
Standard gauge single track; station	
Standard gauge multiple track	
Abandoned	
Under construction	
Narrow gauge single track	
Narrow gauge multiple track	
Railroad in street	
Juxtaposition	
Roundhouse and turntable	
TRANSMISSION LINES AND PIPELINES	
Power transmission line: pole; tower	
Telephone line	
Aboveground oil or gas pipeline	
Underground oil or gas pipeline	
BOUNDARIES	
National	

State or territorial	
County	
Civil township	
Incorporated city	
Park, reservation, or monument	
Small Park	
LAND SURVEY SYSTEMS	
U.S. Public Land Survey System	
Township or range line	
Section Line	
Found section corner; found closing corner	
Witness corner; meander corner	
Other land surveys	
Township or range line	
Section line	
Land grant or mining claim; monument	
Fence line	
CONTROL DATA AND MONUMENTS	
Horizontal control	
Third order or better, permanent mark	
With third order or better elevation	
Check spot elevation	
Coincident with section corner	
Unmonumented*	
Vertical control	
Third order or better, with tablet	
Third order or better, recoverable mark	
Bench mark found at section corner	

Spot elevation	× 5.3
Boundary monument	
With tablet	BM ▫ 21.6
Without tablet	▫ 171.3
With number and elevation	67 ▫ 301.1
U.S. mineral or location monument	▲
RIVERS, LAKES, AND CANALS	
Intermittent stream	
Intermittent river	
Disappearing stream	
Perennial stream	
Perennial river	
Small falls; small rapids	
Large falls; large rapids	
Masonry dam	
Dam with rock	
Dam carrying road	
Perennial lake; Intermittent lake or pond	
Dry lake	
Narrow wash	
Wide wash	
Canal, flume, or aquaduct with lock	
Elevated aquaduct, flume or conduit	

Aquaduct tunnel	
Well or spring; spring or seep	
SUBMERGED AREAS AND BOGS	
Marsh or swamp	
Submerged marsh or swamp	
Wooded marsh or swamp	
Submerged wooded marsh or swamp	
Rice field	
Land subject to inundation	
MARINE SHORELINE	
Approximate mean high water	
Indefinite or unsurveyed	
BATHYMETRIC FEATURES (water depth)	
Area exposed at mean low tide; sounding datum	
Channel	
Offshore oil or gas: well; platform	
Sunken rock	
BATHYMETRIC CONTOURS	
Index	
Intermediate	
Supplementary	

See USGS Brochure for complete topographic map symbol list.

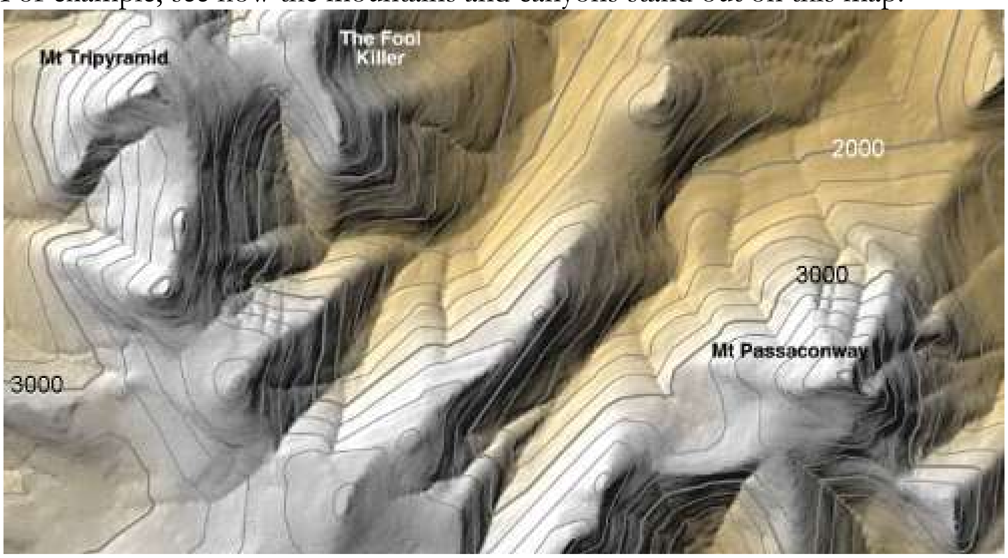
Topo Map Skills

A Topographic Map includes *contour lines* drawn to represent changes in elevation. When you follow a path on a topographic map that crosses these contour lines, you will be either climbing or descending. A path running parallel to contour lines is relatively flat.

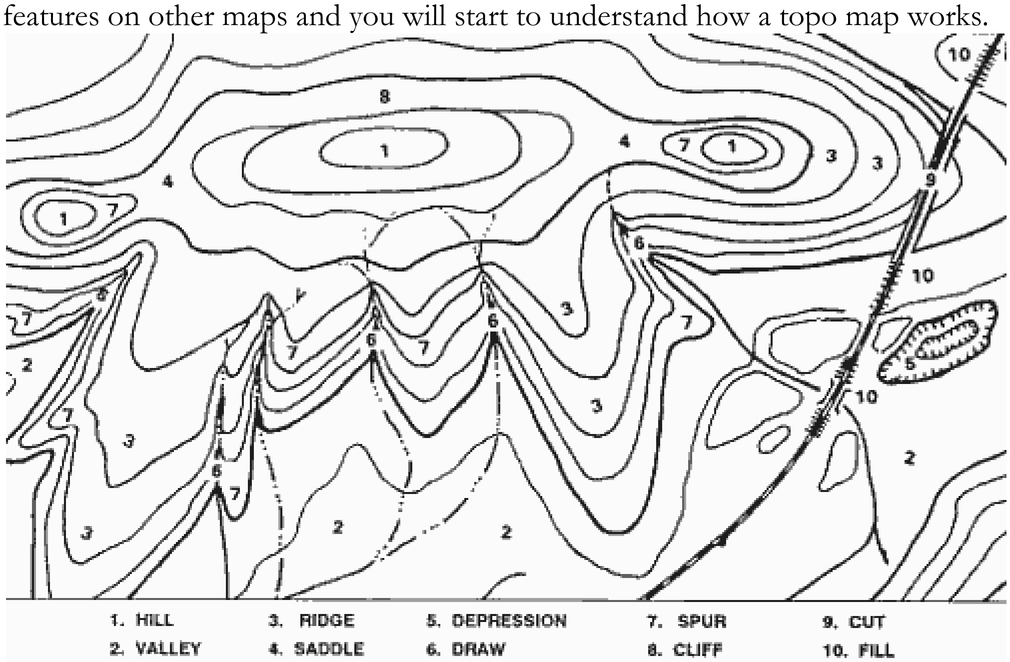
When reading a topographic map, you need to visualize in your mind's eye a 3-dimensional view of what the symbols and contour lines are representing.

The most important thing to remember is that CLOSE contour lines mean STEEP terrain and OPEN contour lines mean FLAT terrain.

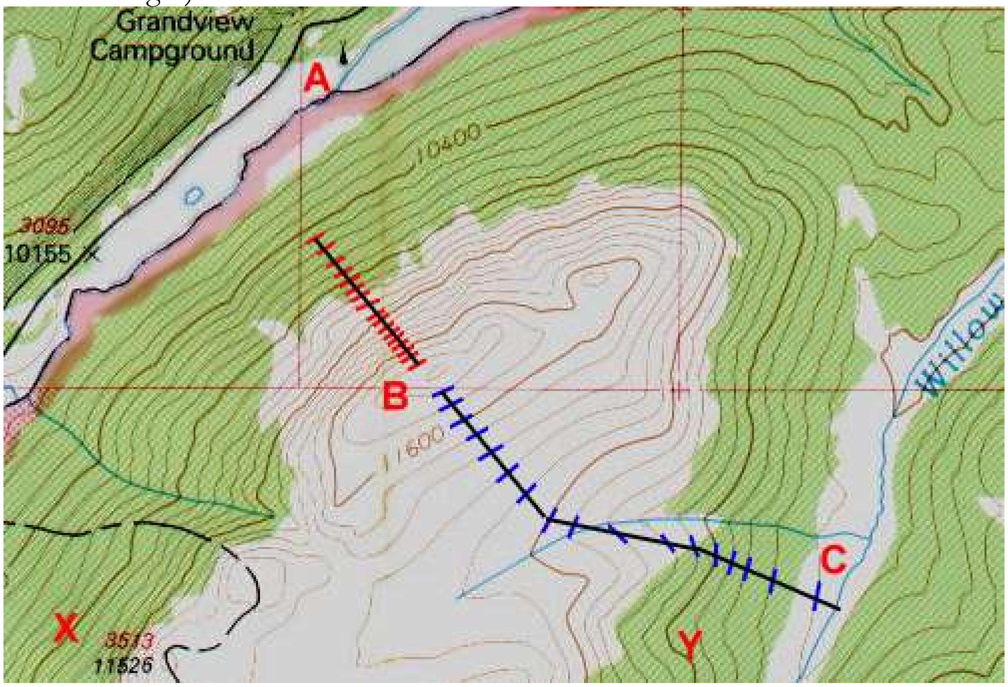
Shaded relief added to a topographic map makes it more realistic and helps visualize the real landscape.
For example, see how the mountains and canyons stand out on this map:



What is the elevation of Mt. Passaconway? _______________
What is the elevation of Mt. Tripyramid? _______________
The closest Index contour line for both peaks is 3,000 feet. You can see another Index line of 2,000 feet. There are 4 Intermediate lines between 2000 and 3000 so each intermediate line represents a 200 foot change in elevation. Counting up from 3,000 feet, there is 3200, 3400, 3600, 3800, and the top line is 4000 (actually the next index line). So, both peaks are over 4000 feet and it looks like Mt. Tripyramid is possibly almost 4200 feet high.
This example of a very simple topographic map shows many common features. Keep your eyes open to see these features on other maps and you will start to understand how a topo map works.



Even without elevation numbers, clues that #1 is a hill include streams converging away from the hilltop, contour lines pointing sharply towards the hilltop (indicating draws), contour lines pointing widely away from the hilltop (indicating rounded ridges).



Using contour lines, you can tell a lot about the terrain, including steepness, ruggedness, and ground cover. On the image above, look at point **A**. There are no contour lines around this location so it is relatively flat here and a good place for a campground by the lake. You can tell from the elevation listed at marker 3095 that the campground is at 10155 feet.

You can also tell the elevation change between each contour line by looking at the Index lines. Notice that the Index line near point **B** is labeled 11600 feet and the one due north of it is labeled 10400 feet - that is a difference of 1200 feet. Between these two Index lines are two more Index lines so each index line represents a change in 400 feet of elevation - 10400, 10800, 11200, and 11600.

Count the lines between two index lines and you should see there are 4 lines which cause the 400 feet between the two index lines to be divided into 5 intervals, each one being 80 feet in elevation. So, now we know that *on this map* every contour line represents 80 feet of elevation change.

If you follow a single contour line, your elevation remains constant. For example, starting at point **X** and following the Index line to the NorthEast, around, and down South to point **Y**, you would stay at about 10,800 feet.

When you cross contour lines, you are either hiking up or down. Look at the two routes to get to the peak at point **B** - the red route and the blue route. Each path reaches the top, but the blue route is three times as long as the red route. That means it covers more distance to gain the same elevation so it is a more gradual slope - and probably an easier hike. Going up the red route may require a lot of scrambling and hard work.

Using the map above, pretend you are camped at the Grandview Campground but you heard there is great fishing in Willow Creek at point **C** over the mountain to the SouthEast. How could you get there?

Well, a straight line to the SouthEast would be shortest on the map, but would include a climb of over 1500 feet! Instead, heading East from camp and circling the north side of the mountain will result in a longer distance covered but only about 325 feet in elevation! That may be a much better hike.

One other thing to take into consideration. Notice that the ground is colored green up to about the 10,800 foot index line. The white area above that is open ground while the green area is forested. This can be good or bad. The forest can offer shade and coolness, but on the other hand it may be thick and difficult to navigate.

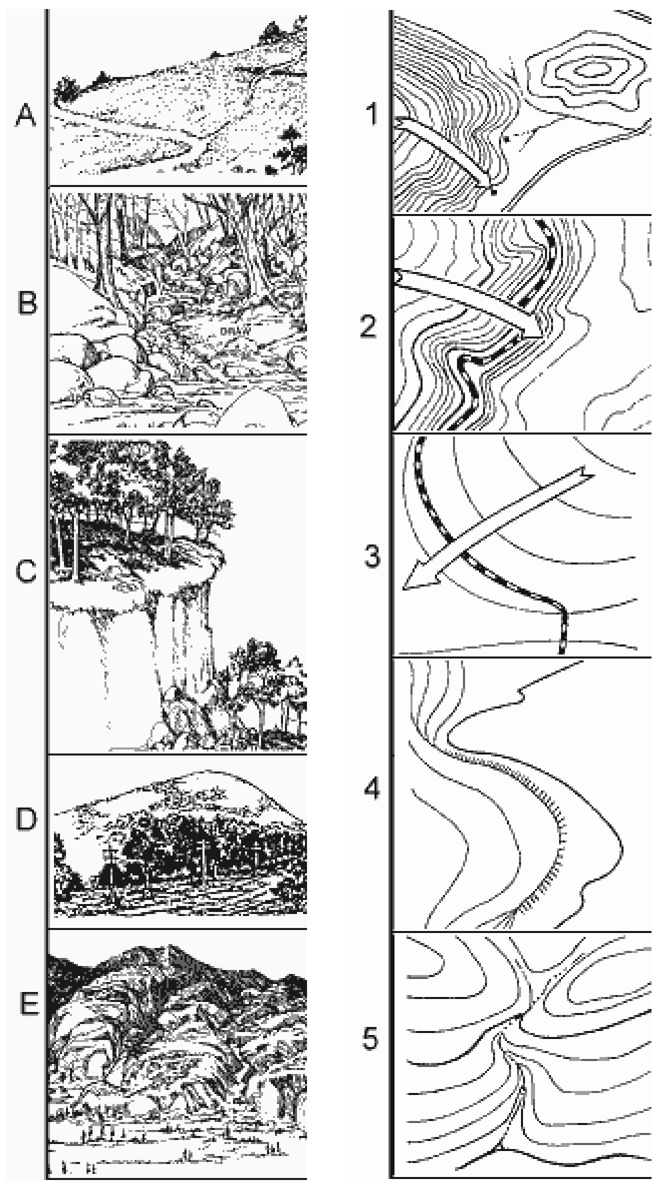
Contour Line Quiz
Contour Map Quiz

Match the contour line drawing in the **PHOTO** column with the corresponding contour line image in the **TOPO** column. See the bottom of the page for answers to contour map quiz.

Hint #1: The Arrow in the TOPO images point **downhill**.

Hint #2: Don't get frustrated with the answers. A couple are very similar.

PHOTO **TOPO**

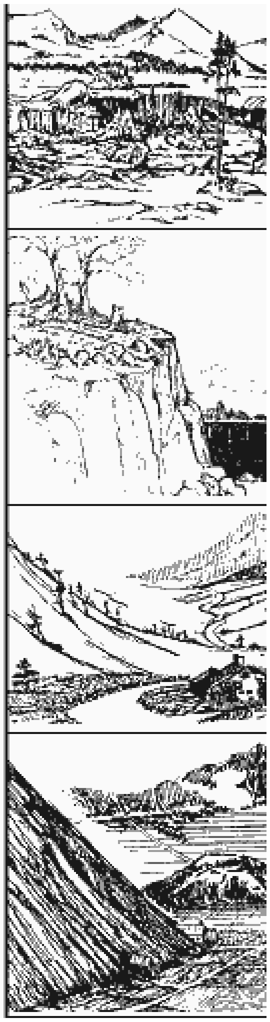


F

G

H

I

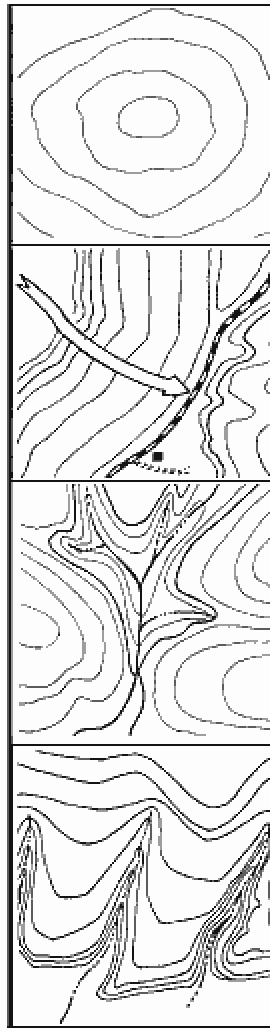


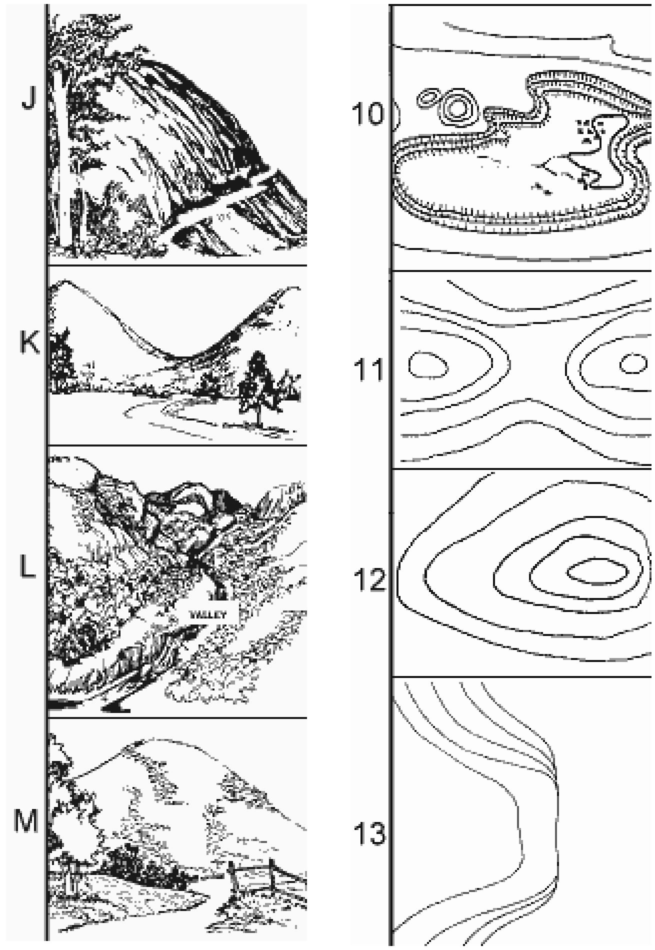
6

7

8

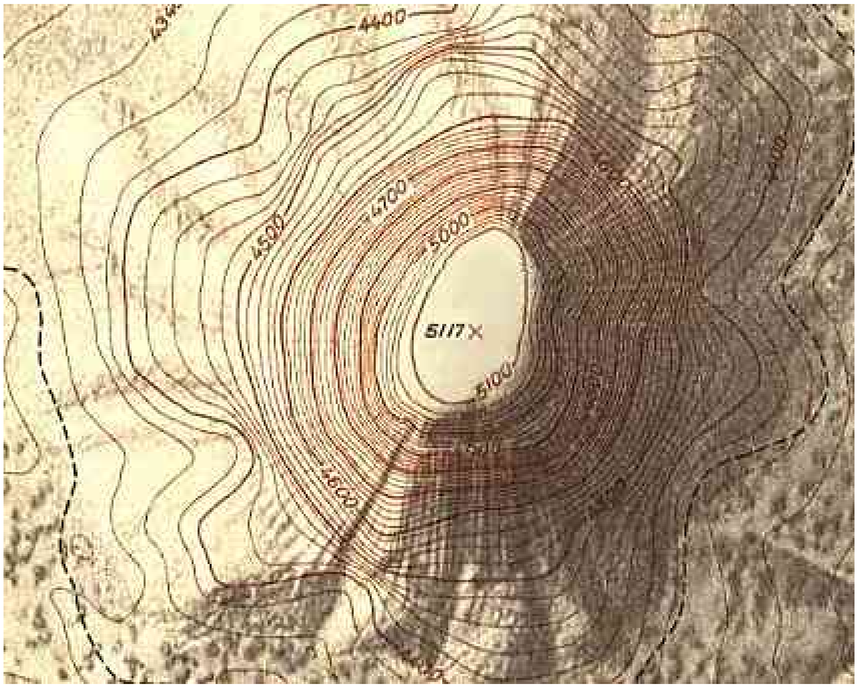
9

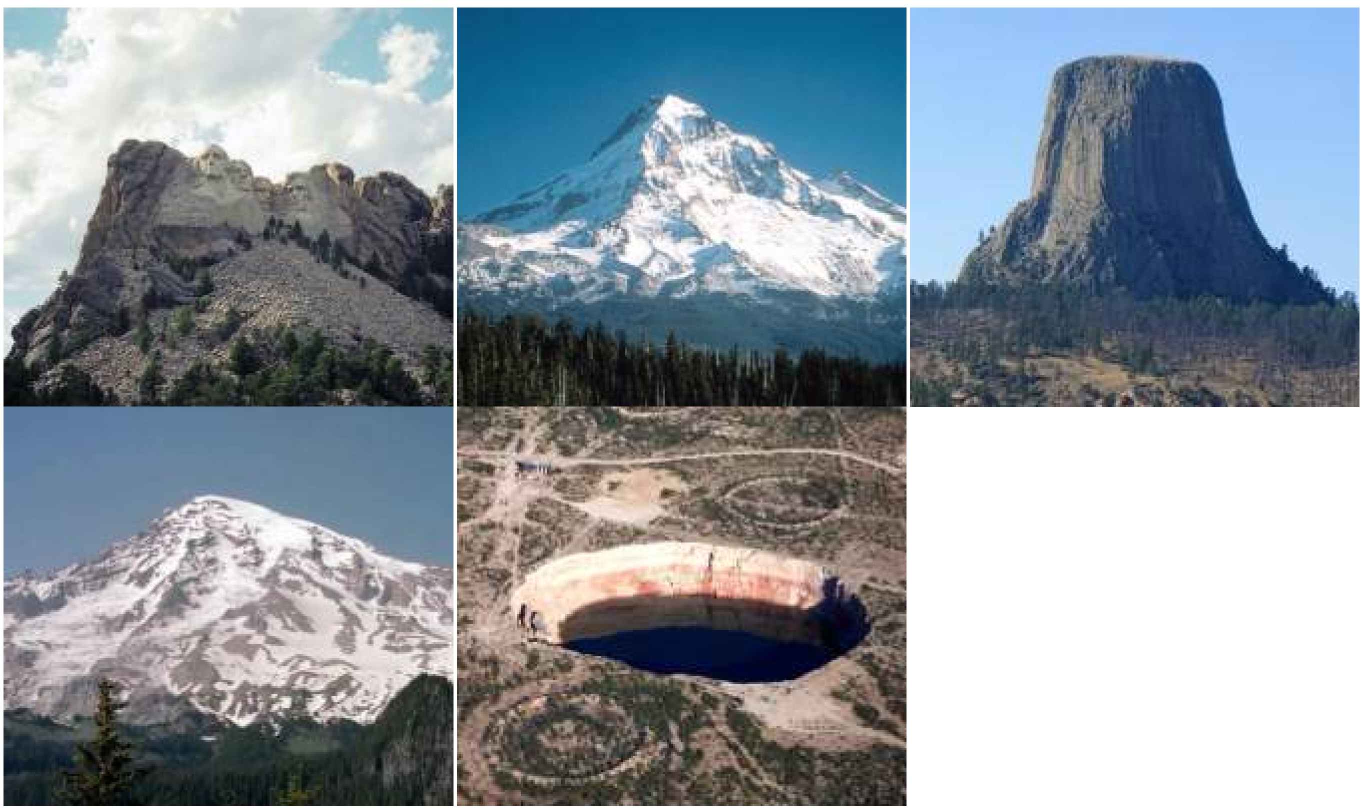




A 3 - gradual, consistent slope
b 5 (or 8) - draw or valley with stream
c 13 (or 4) - cliff face
d 12 - hill with ridge
e 9 - spurs on a mountainside
f 10 - a depression
g 4 (or 13)
h 7 - Steeper slope high, gradual low
i 1 - consistent slope
j 2 - gradual slope high, steeper low
k 11 - a saddle between two hills
l 8 (or 5)
m 6 - simple round hill

The contour map below uses a 1:4,800 scale. Notice the shaded relief to improve the map. Using what you've learned about contour lines and topographic maps, figure out which photo goes with the map.





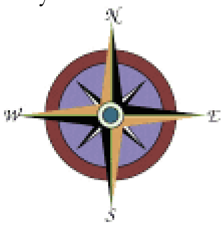
Answer: The contour lines are very close together, indicating an extremely steep slope that rises from 4500 feet to 5100 feet - that is about 2 football fields standing on end.
A perfect bulls-eye shape is created, indicating a circular mountain.
The open center circle inside the 5100 contour line indicates that the top of the mountain is a flat plateau.

This topgraphic map is of **Devil's Tower** which is the photo in the lower left.

Using a Map and Compass

If you understand how to read a compass and how to read a map, then its about time you learned to use both map and compass together.

Separately, a good map or compass can be very useful, but limited. Together, they can lead you around the world (and back again!) but you need to know how to use them properly. The next few pages will help you understand some key skills in order to be a successful outdoors dude and impress your friends with your map and compass mastery - well, maybe at least not get too lost!

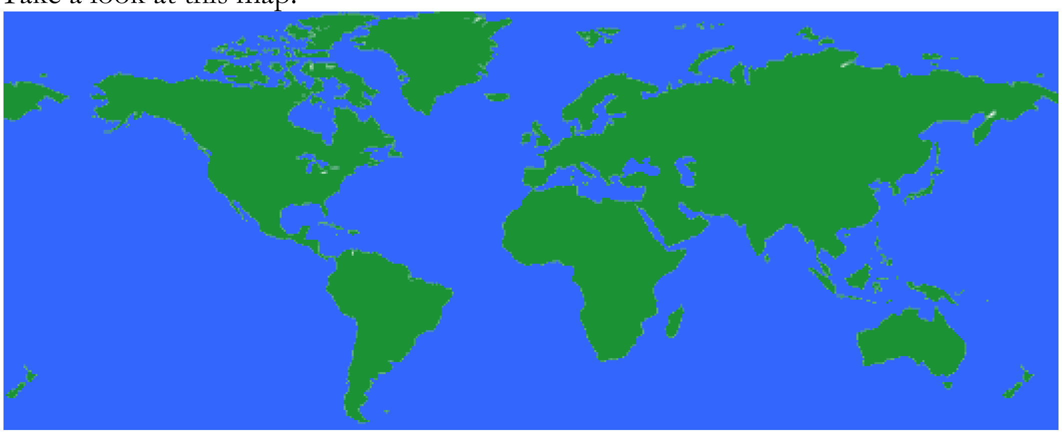


Latitude and Longitude Coordinates

Every single spot on the earth can be identified by a global latitude and longitude coordinate system - whoa, big words, dude!

Well, let's slow down a bit. Latitude and longitude are just used to pinpoint your location. Translating the earth to a map requires some sort of agreed-upon way to describe each spot.

Take a look at this map:



Obviously, that is a map of the earth. You can find the continents and can probably make a good try at pointing to where you live. But, how could you tell someone else where you live so they could quickly find it on their own map? That is where a coordinate system helps.

The Axis

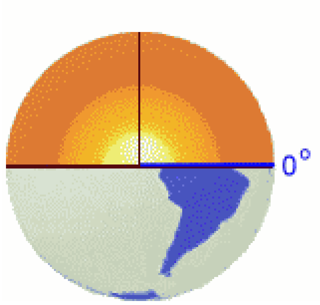
Our coordinate system is going to be based on the spinning earth. The earth spins around on its axis. One end of the axis is the North Pole and the other is the South Pole. These are the two most important points on earth as far as directions and navigating are concerned.

The most important number for figuring out locations is **360**. There are 360 degrees in a circle and that is the shape of our world, no matter how you slice it.

Latitude

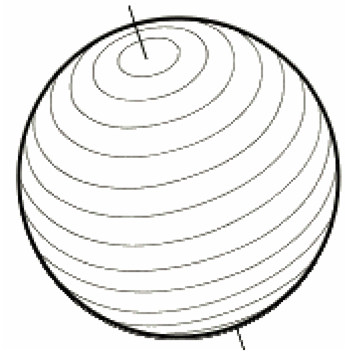
If you could stand at the center of the earth, you could look out at the surface of the earth all around you. With the North Pole directly above your head, if you looked straight ahead in any direction, you would be looking at the *equator*. This imaginary line is exactly halfway between the north and south poles and has a latitude of 0 degrees because you are looking straight ahead at an angle of 0 degress. If you look up a bit, maybe at an angle of 30 degrees, you have increased your latitude to 30 degrees North. Continue to look up higher and higher until you are looking straight above you at the north pole which is 90 degrees North.

Maybe this image will help:



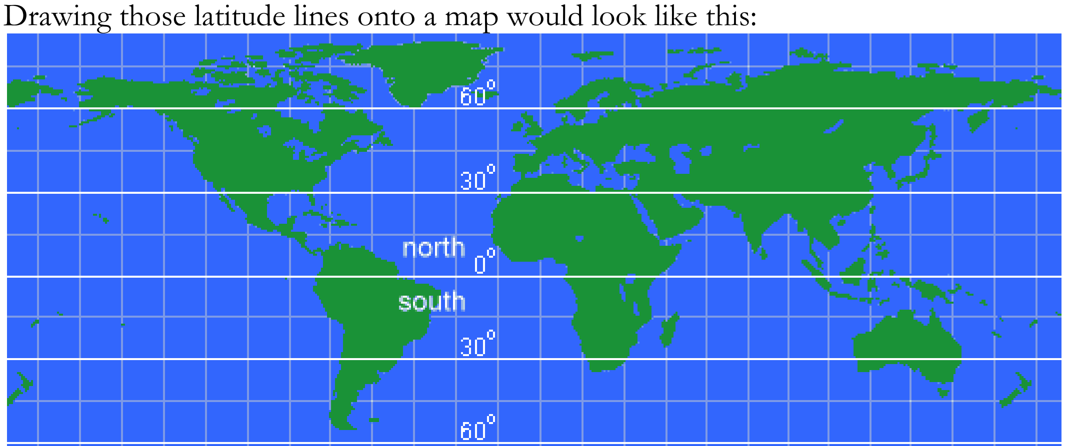
The same thing happens if you look down under the equator. The degrees increase until you are looking straight below you at the south pole which is at 90 degrees south latitude.

Just like the equator is a line drawn around the earth at 0 degrees latitude, you can draw a line around the earth at any latitude. Draw a lot of these lines and you will see something like this:



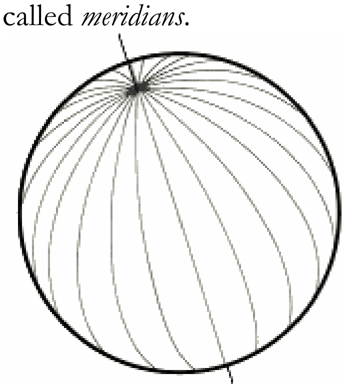
90 degrees north and 90 degrees south are are actually just points, not circles. Notice that each latitude is parallel to all others. The actual distance between latitudes is always the same. But, since greater latitudes are closer to the poles, circumferences get smaller as latitudes increase.

Drawing those latitude lines onto a map would look like this:



Longitude

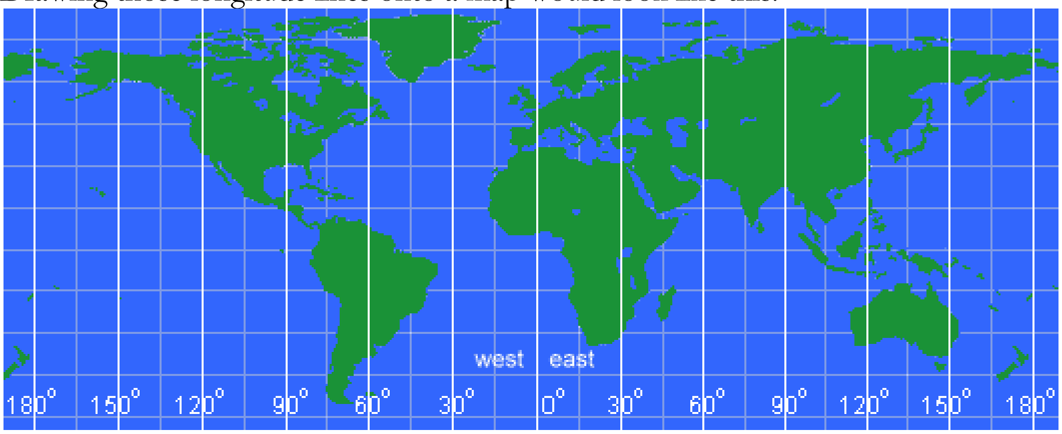
Longitude is the angle east or west around the earth, just like latitude is the angle north and south. Longitude lines are called *meridians*.



For latitudes, we have two fixed points - the north and south poles - that we use as end points. But, going around the earth, there is no start or stop, it just keeps spinning and spinning. So, an arbitrary spot was chosen to be the *Start* point for longitudes. This spot is the Royal Observatory in Greenwich, UK. The longitude line that runs through it is called the *Prime Meridian* and is longitude zero degrees.

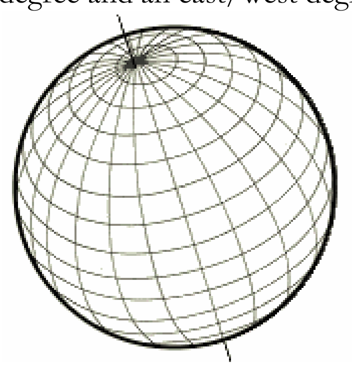
Notice that longitude lines are not parallel. The closer to the poles you get, the shorter the distance between meridians until they all actually converge at the poles.

Drawing those longitude lines onto a map would look like this:



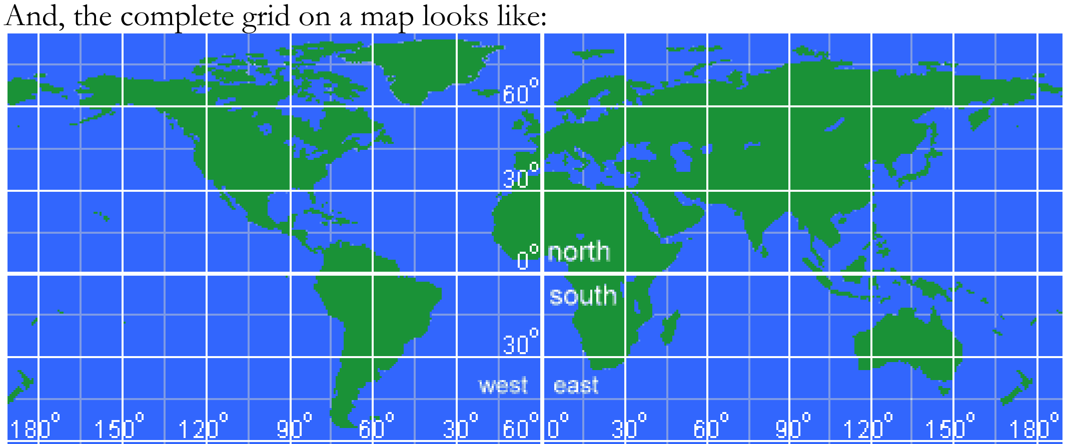
Latitude and Longitude Grid

Combining latitude and longitude results in a grid that covers the globe. Every point can be defined by a north/south degree and an east/west degree.



For example, Seattle, Washington, USA is at latitude 47.6° North and longitude 122.33° West. From the center of the earth, look up 46.6° from the equator and turn right (west) 122.33° from the Prime Meridiean and you will be looking right at Seattle.

And, the complete grid on a map looks like:



Well, degrees are fine and good, but the earth is almost 25000 miles around so dividing that into 360 pieces means each degree is about 69 miles wide around the equator. That isn't very precise. To help with that, each degree is divided into 60 minutes and each minute is divided into 60 seconds. These used to be used all the time, but now fractional degrees are more common.

For example, the location of the White House in Washington, DC is:

	Decimal Degrees	Deg:Min:Sec
Lat:	38.898648N	38° 53' 55.133" N
Lon:	77.037692W	77° 02' 15.691" W

USGS topographic maps are called 7.5 minute maps because they span 7.5 minutes of latitude and 7.5 minutes of longitude. The most common latitude and longitude map is a 1:24,000 scale and the actual map size is about 22 inches by 27 inches. By the way, it takes about 57,000 of these maps to cover the entire US and you can buy any of them you want. Start your collection today! :-)

That's about all there is to latitude and longitude coordinates! Here's some tips to remember:

- Latitude is always given before longitude (49° N 100° E)
- Latitudes are parallel, but longitudes are not
- Degrees West and South are sometimes referred to as negative degrees (-12° -23° is the same as 12 S 23 W)
- A place's latitude effects its climate, but its longitude does not
- Key longitude lines are the Prime Meridian (0°) and the International Date Line (180°)
- Key latitude lines include the equator (0°), tropic of cancer (23° 26' N), tropic of capricorn (23° 26' S), the arctic circle (66° 33' N), and the antarctic circle (66° 33' S)

Compass Declination

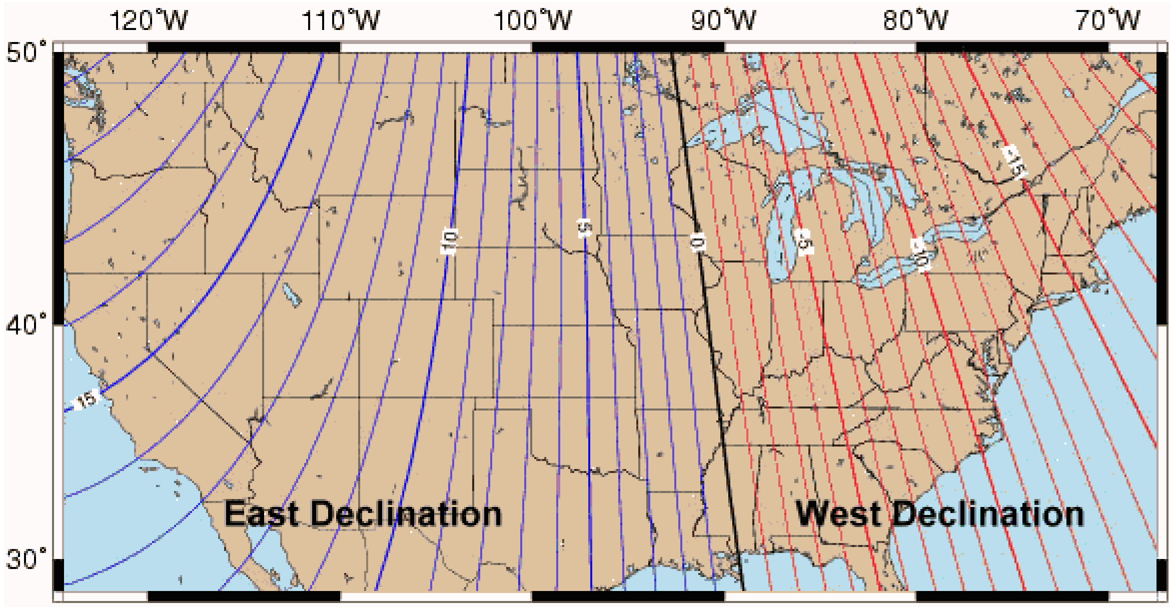
- Man, you thought latitude and longitude was rough, just check out this declination stuff!
- I'm sorry to be the one to tell you that your compass doesn't work quite right. It doesn't really point to the north pole or the south pole.
- Not only that, next year it will point someplace different than it does this year! And, someday it may be completely backwards!

Two North Poles

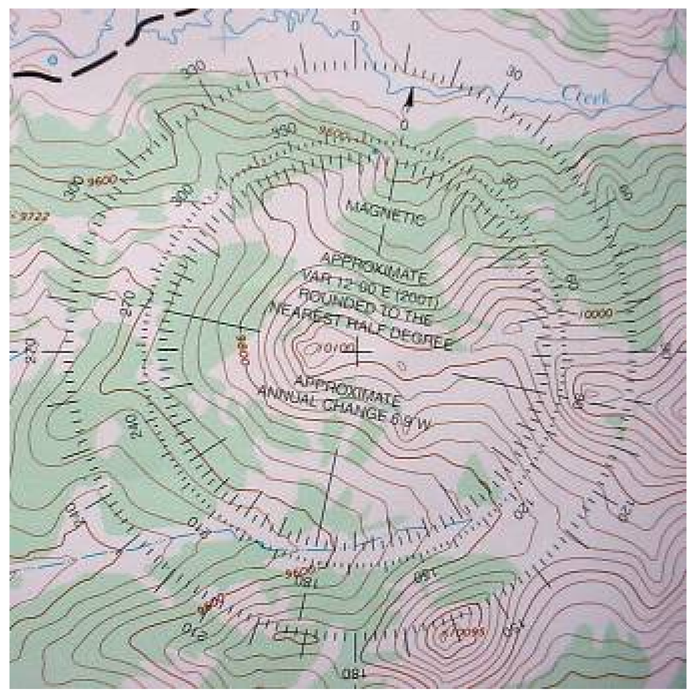
- There are actually two north poles - the *Geographic* north pole which is the axis around which the earth spins, and the *Magnetic* north pole which is where compass needles point.
- Why are there two different poles? Good question!
  The magnetic north and south poles are the ends of the magnetic field around the earth. The magnetic field is created by magnetic elements in the earth's fluid outer core and this molten rock does not align perfectly with the axis around which the earth spins.
- There are actually many different sources of magnetic activity around and in the world. All those influencing factors combine to create the north and south attractions at each spot on the globe. The actual strength and direction of 'north' is slightly different everywhere, but it is generally towards the 'top' of the planet.

Magnetic Declination

- The difference between the north geographic pole and the north magnetic pole is called *magnetic declination* or usually just declination.
- Depending on where you are on the earth, the angle of declination will be different - from some locations, the geographic and magnetic poles are aligned so declination is minimal, but from other spots, the angle between the two poles is pretty big.
- Here is a map of the current angles of declination for the U.S.:

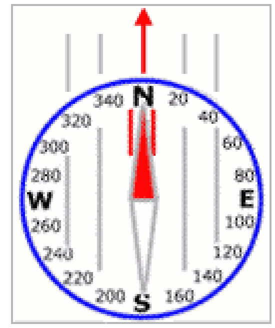


- Notice the black line with **0°** on it running down the Mississippi river? Along this particular line, both the geographic and magnetic north poles are in alignment so there is no declination. If you move East of this line, the magnetic north pole will pull your compass needle further and further to the West of geographic north - the angle of compass declination is West Declination. Moving west of the Mississippi river will pull your compass needle further and further to the East.
- This makes it a bit more challenging to find your way because your compass tells you North is a different direction, depending on where you are. Topographic maps used for navigating should have the declination printed on them like this example. This declination is for an area in the Bighorn Mountains in Wyoming where the declination is 12 degrees East in 2001, when the map was made.
  (Click the image for a bigger version)

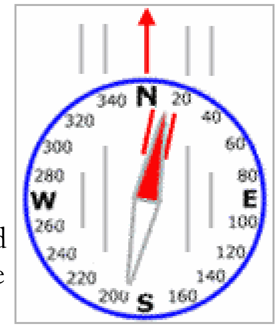


  It also says that the declination is changing 6.9 minutes West each year. Using this old map, the declination would be about 11 degrees East in 2010 - about 1 degree less than the map has printed.
  Unfortunately, the rate of declination change changes over time. When the map was printed, the rate of change was 6.9 minutes West each year. But, it has now sped up to 9 minutes West each year. This has been changing every year since the map was printed so the *current* declination for this area is 10 degrees 41 minutes East. That is already a larger change than what we would expect for 2010, based on the map's information.
- Does it make good sense to use a map's declination information if that map is more than a couple years old? **NO**, you should use recently published maps or know the current declination for the area and use that information for your navigation.
- There are a few ways to solve this extra challenge of finding true north - either changing your compass or using math in your head.

Adjust Your Compass

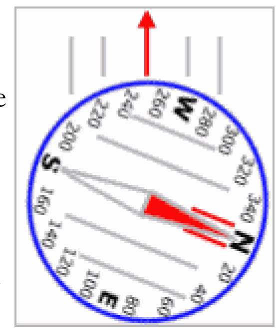


- On many compasses, you are able to adjust the declination by twisting a ring, using a screw, or some other method of changing where the *orienting arrow* sits in relation to the ring.
- If you used a compass set with 0 degrees declination in Wyoming where the declination is 12 degrees East, the compass would tell you that you're heading North when you're actually heading 12 degrees East of North.
  You'd quickly wind up off course and lost.



- By adjusting the compass to match the declination on our map, the orienting arrow now appears to be offcenter from North, which is how it should be.
  Now, when you put **RED in the SHED** (needle inside orienting arrow), the North indicated at the index pointer is true north and matches your map.
  You can continue to check your location and chart your course correctly.
  Whenever you stop and check your heading or take a bearing on a distant object, the degrees read on the dial will be the actual true degrees. The only thing that looks a bit odd is that the north end of the compass needle does not point directly at the **N** when you are heading due North.

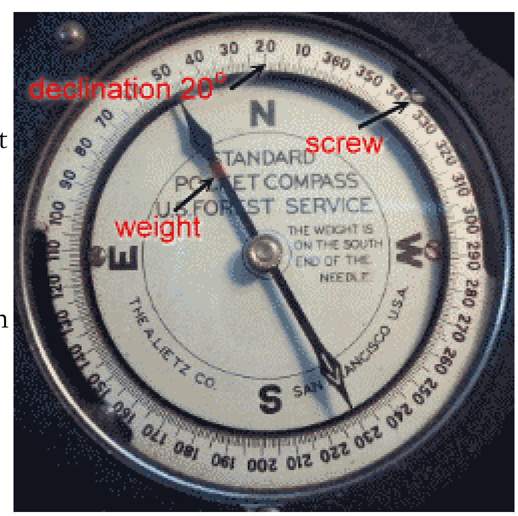
Using Your Head



- If you have a compass with no declination adjustment or you just like math, then you can do the declination calculations in your head.
  If you are in Wyoming with a 12 degree East declination just subtract 12 degrees from the heading you read on your compass dial.

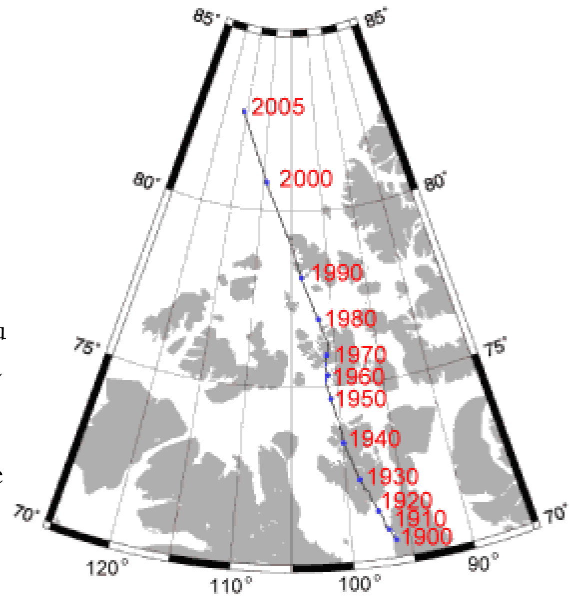
  In this example, the reading is 250 degrees.
  But, you are actually facing 262 degrees.
  So, to actually head 250 degrees, you need to get a reading of 238 degrees and then you're heading the right way.

Inclination



- Inclination is the angle of pull down toward the earth that the magnetic field exerts on a compass needle. At the north magnetic pole, the north end of the needle is pulled straight down toward earth. Using your brilliant mind, you probably figured that a compass doesn't do much good if it is pointing straight down. And, actually, for hundreds of miles around the magnetic poles, compasses are worthless. For even more hundreds of miles around that, compasses can be erratic.
  So, if you are planning an arctic or antarctic expedition, don't count on your Silva or Brunton for getting you there and back.
- Not only that, but there are southern hemisphere and northern hemisphere compasses.
  I have an old Forest Service compass that you can see here. It has a weight on the southern end to offset the inclination pull in the northern hemisphere. If this compass is taken to the southern hemisphere, the weight would cause it to drag and not balance properly.
  You might also notice the two declination adjustment screws and the fact that it is currently set for about 20 degrees East declination. And, you should note that this is not a good compass for mountaineering for many reasons.

The Drifting Poles

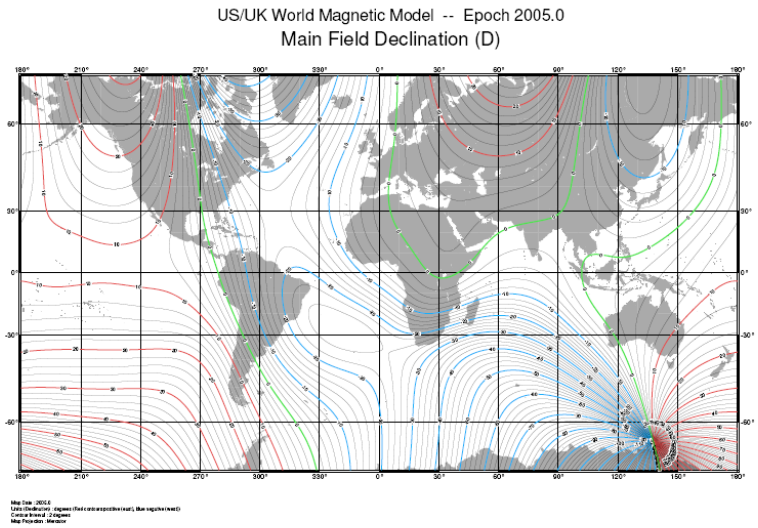


- Back to the magnetic north and south poles - remember I said they were caused by the earth's molten outer core? Well, things are always shifting and churning down there. So, as the liquid rock moves, so does the magnetic field.
- This map shows how the north magnetic pole has shifted over the past century. Notice that it has picked up speed and has moved more in the last 15 years than in the 50 years before that, now moving about 25 miles per year on its way out of Canada and heading to Russia.
- So, how does this effect compass use and navigation? Well, if you follow your compass north this year, you will be drawn towards a different place than 15 years ago. Declinations are constantly changing and that means what is written on a map you buy this year will be incorrect next year. The difference depends on where the north pole moves to and what your current declination is.
- For example, if you pointed north from Fairbanks, Alaska in 2006, you would follow **Line #1**.
  100 years ago, you would have followed **Line #2** - huge difference!
  From other places, such as Winnipeg, Manitoba, **Line #3** in 2006 and **Line #4** 100 years ago are nearly the same.

- These moving magnetic poles continually effect navigation. It's more serious for airplanes and ships, but even for hikers and backpackers, it causes problems. Using a 10 or 15 year old map is a bad idea since the declinations are no longer accurate.
  If the north pole movement continues at its present speed, it moves 250 miles every 10 years, but it has been speeding up so no one knows what the next 10 or 20 years hold in store. Historically, the magnetic field of the earth has churned over and reversed and some scientists say we are well overdue for such a reversal.

Set Your Heading

Now that you understand that a map has north-south lines on it representing longitudes and your mountaineering compass points to magnetic north, you can take readings from a map and navigate across country following a course of your choosing. Being able to do this is the simplest use of a map and compass together so let's tackle it.

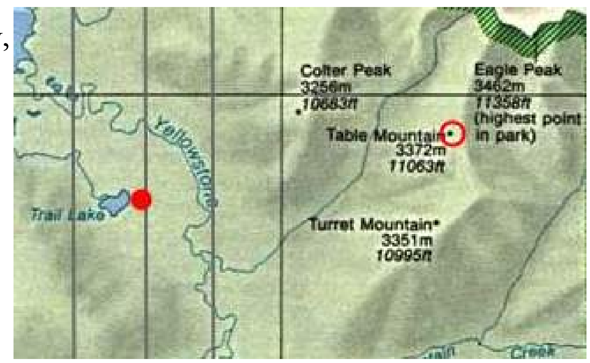


Read a Heading

To read a heading from your map, you just need to know where you are on the map and where you want to go. Let's say you are camping on the east shore of Trail Lake. You've woken up, had a great breakfast of maple and brown sugar oatmeal (with raisins), and packed camp.

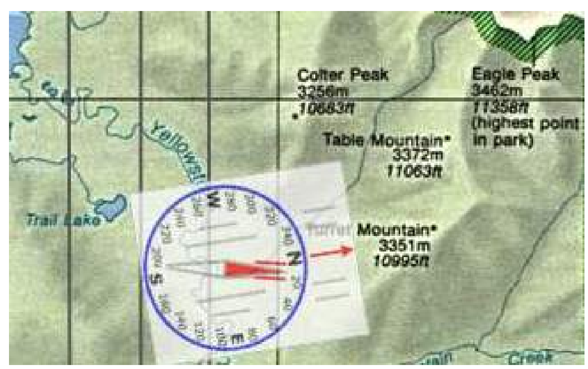
Today, you want to hike to the top of Table Mountain. Unfortunately, you can't see the mountain from camp because the ridge running south from Colter Peak is blocking the view. You need to figure out what heading to take to reach Table Mountain and what course to follow using your compass.

For right now, just ignore the needle on your compass. It will be important in a minute, but right now you just want to use the baseplate, dial, and orienting lines of your compass.



Step-by-Step

- Lay your map on the ground - it can be facing any old direction.
- Find your current location on the map and where you want to go.
- Lay your compass on the map so one edge makes a perfect line from where you are to where you want to be. If the distance is too far, use a straight-edge of some kind to line up the two points - a piece of paper, edge of another map, tent pole, anything that is straight. Then, place your compass edge up against this line.
- Holding the compass in place, turn the compass dial until the orienting lines are parallel to the north-south meridian lines on the map. This is making North on your compass dial match North on the map. (don't worry about the needle yet)
- Now, you have taken the bearing. The direction at the index pointer is the direction in which you must head to reach your destination. In this case, it is about 85 degrees.
- Pick up your map and put it away.
- Now you need to pay attention to your compass needle! Hold your compass flat in your hand and turn your body and compass until **RED is in the Shed**. Of course, you are now facing the direction in which you need to travel.

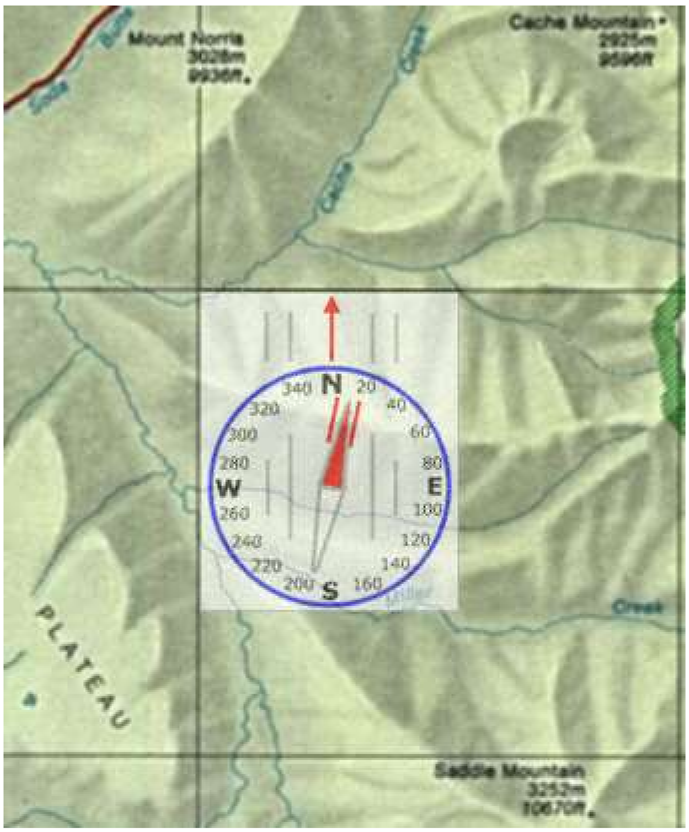


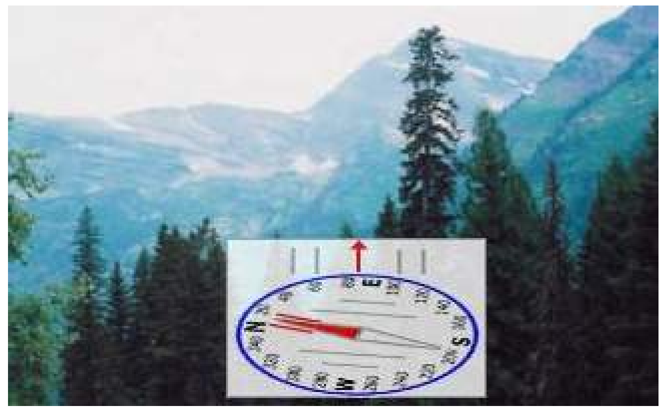
Figuring your heading from a map is the most basic way to use a map and compass together to plot a course of travel. It is often all you need to do, but sometimes you are able to better figure out a situation by having the map laid out on the ground so it lines up with the real world around you.

Orienting a Map
A map represents the real world. By orienting a map, you are positioning it so its North is actually pointing north. When you orient a map and know where you are on the map, you can look in a certain direction and see a real landmark and find it on the map.

Orienting, or aligning, the map is really easy with just 3 steps:

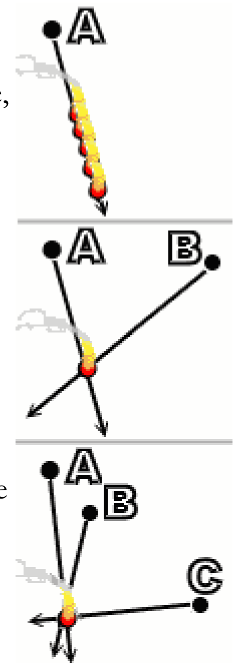
- Lay your map out on a relatively flat, smooth surface.
- Turn your declination-adjusted compass dial so due North is at the index pointer.
- Place your compass on your map with the edge of the baseplate parallel to the north-south meridians on the map. Notice the orienteering lines and direction-of-travel arrow are all parallel with the map lines.
- Turn the map and compass together until the compass needle is "boxed" in the orienting arrow (**Red in the Shed**).





Now, the map is oriented to the real world. If you know where you are on the map, you should be able to look in any direction and see the objects represented on the map in the same direction.
If you know where you are on your map, you can also orient your map by distant features. If you can see a known mountain in one direction and a lake off another way, then just lay the map out and turn it so the corresponding marks on the map align with the distant features.

Triangulation
Triangulation is the process of pinpointing the location of something by taking bearings to it from two remote points. Forest fire lookout towers used triangulation to locate spot fires.



A ranger at **Tower A** would see smoke in the distance and take a bearing to it on his compass. This single line was not enough information to locate the fire because it could be anywhere along that line, close or many miles away.

The ranger would radio **Tower B** and tell him the general direction of the fire. Tower B would then find the fire from his viewpoint and take a bearing. Where the two bearings crossed would pinpoint the fire and firefighters could be efficiently dispatched to put it out.

Sometimes, a third tower would be used to verify the location, but two readings are all that is usually necessary. If a fire occurs directly between two towers or off in a direction that causes their bearings to be similar, then a third bearing is necessary.
This type of triangulation is used by two fixed spots to find a third unknown spot. What you need to do while in the outdoors is similar, but you need to find out where you are, not where something else is.

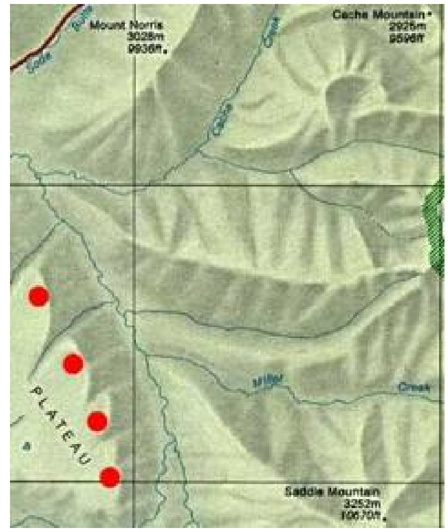
Finding Yourself
In order to successfully triangulate, known features must exist on your map. In other words, you must have some idea of where you are or be able to identify a well-known landmark from your viewpoint.
By taking bearings to the distant landmarks, you can plot your current location on your map in this way:

- Make sure you have adjusted your compass correctly for declination in this area.
- Orient your map so map north is facing true north.
- Take a bearing to one landmark. Point the direction of travel arrow at it and turn the compass dial until **RED is in the Shed**.
- Place your compass on the map so that the orienting lines are parallel to the map's north-south meridian lines.
- Move your compass so the top end of one edge of its baseplate ends at the landmark, keeping it aligned with the map's meridians.
- Draw a line along the edge of your compass from the landmark along the bearing you took. You are somewhere on this line.
- Repeat taking a bearing and drawing a line for a second landmark.
- Where these two lines intersect is your approximate location.

If you are standing on a known landmark such as a road, river, or ridgeline but don't know where on that landmark you are, a single remote landmark is enough to plot your position. Where your bearing line to the remote landmark and the landmark you are on intersect is where you are - as long as you take accurate readings and transfer them accurately.

Triangulation Example

This example will step you through the process of triangulating your location based on bearings to two or more known landmarks.

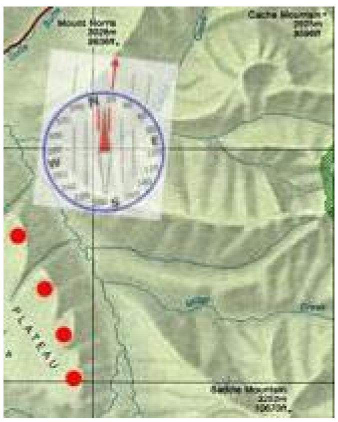
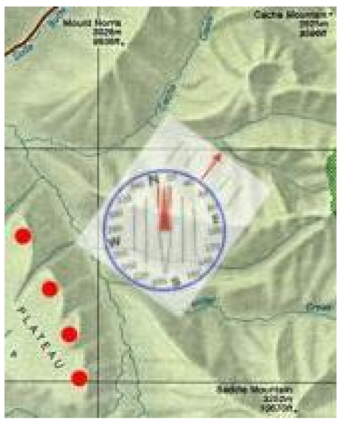
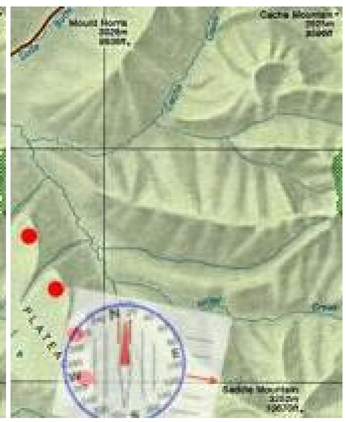


Look at this section of map - it has mountains, streams, and hills as indicated by the shaded relief enhancements. Notice it does not have contour lines but that doesn't matter when we are just finding directions.

You might find it useful to print the image and actually do these steps.
Print the map and lay it on the floor.

Orient the map for North right where you are and imagine that you can see mountains off in the distance.

You have just climbed the plateau in the southwest, coming up from the southwest. You do not know at which of the 4 red spots you are currently standing, but you can see 3 mountains off in the distance towards the north and east.

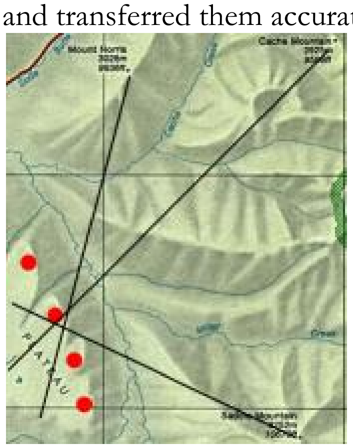




For your triangulating, you take bearings to the mountains and get:

- 16 degrees to Mt. Norris
- 48 degrees to Cache Mountain
- 112 degrees to Saddle Mountain

To simulate taking each of these bearings, turn your compass dial until that bearing is at the index pointer. Then, turn the compass until **RED is in the Shed** and the direction-of-travel arrow will be pointing along that bearing.

Transfer your bearings to the map and find out where they intersect. If you oriented your map, took correct bearings, and transferred them accurately, your map should look close to:



Now you know where you are on the map and in the real world. If you didn't do too good on this one or want to try another, here's another exercise to try.

Planning Routes

With a map, a compass, some time, and all the knowledge you've learned so far, you can plan out your next wilderness trek from the comfort of your own warm home. Why bother doing this?

- You'll know how far each day's hike will be.
- You'll know where to set up camp.
- You'll know when to expect strenuous and easy terrain.
- You'll be more familiar with the area in general so if you do get lost or injured, you have better chances for survival.
- You'll leave a copy of your trek plan with other people to help with rescue efforts if things go wrong.
- It's fun!

Waiting for water to boil for dinner is a great time to check out tomorrow's route and discuss what to expect on the trail ahead. Every day on the trail should include a time to review how well you are following your plan and what adjustments need to be made.

To plan your route,

- Get oriented with where you are on the map - your current position.
- Figure out where on the map you want to go - your destination.
- Examine the space between the two points. Look for obstacles such as swamps, lakes, rivers, cliffs, mountains, and such that you may need to go around rather than through or over.
- Find the easiest, prettiest, shortest, or in some way *best* path to your destination - its up to you.
- From your starting point, put your compass on your map and Read your Heading for the first leg of your trek by adjusting the orienting lines of the compass with the meridian lines on the map and reading the direction at the index pointer.
- Using the map scale, estimate how far this leg will be.
- Considering the contour lines and terrain features, estimate how long this leg will take to cover. Remember, going uphill will take longer. Higher elevations will take longer. Having no trail will take longer. Thick forests, large rock fields, sand, ... will take longer.
- Record your details on your trek plan and repeat for each leg of your trek.

Trek Plan Exercise

You have volunteered to help with some conservation needs in the local mountains. You and two friends are planning a short trek in which you hope to accomplish these tasks. The first four are your job, but the other two are just for fun:

1. Check the Medicine Bow Peak trail for down trees or other obstructions for a trail crew to fix in two weeks.
2. Check the Wiant Number 2 Dam for winter damage.
3. Check Ryan Brothers Lake Dam for winter damage.
4. Find and remove a geocaching site reported on the peak overlooking Lookout Lake.
5. See how good the fishing is in Dipper Lake in the morning and evening.
6. Get a picture of the sunrise on Medicine Bow Peak from the top of Sugarloaf Mountain.

To start preparing your route, find out the following details about your map:

- Each Index contour line is _____ feet.
- Each Intermediate contour line is _____ feet.
- The local declination is _____ degrees East.
- The map scale is 1 inch equals _____ miles (or whatever the reproduced scale gets resized to).

Using your map and compass, do the following:

- Decide where and when you will be dropped off.
- Decide the route through the mountains you will take.
- Decide where you will camp each night.
- Decide where and when you will be picked up.
- Adjust the declination of your compass, or figure out how to point true north.
- Figure out each leg of your trek, writing down important information in your trek plan.

Trek Plan			Date: _______		
Leg #	Description of Leg	Heading	Distance	Start Time	Hike Time
1	_	_	_	_	_
2	_	_	_	_	_
3	_	_	_	_	_
4	_	_	_	_	_
5	_	_	_	_	_
6	_	_	_	_	_
7	_	_	_	_	_
8	_	_	_	_	_
9	_	_	_	_	_
10	_	_	_	_	_
11	_	_	_	_	_
12	_	_	_	_	_
Total Miles:			_______		
Total Hiking Time:			_______		

Some questions to ask yourself:

- Did I identify rough terrain and give more hiking time for those miles?
- Did I camp in a fairly flat, protected area, safe from flooding and off of trails?
- Did I use existing trails as much as possible?
- Did I reach camp well before darkness with plenty of time for setting up camp and making dinner?
- Did I avoid fragile or potentially dangerous terrain such as swamps and rock slides?
- Did I meet all my trek goals?

Pacing Distances
Pacing

In orienteering or treasure hunting, it is often valuable to count your paces in order to estimate the distance you've traveled in a certain direction. Knowing the length of your pace is useful for many things such as estimating the width or height of large objects such as trees, rivers, or cliffs. But, in wilderness hiking, I've actually found no real use yet for counting paces. I'd love to hear from you if you've used pacing for a real situation and I'll post it here.

Figuring Pace Length
To determine your pace:

- Accurately measure a distance - using a 100 yard (300 feet) football field is perfect.
- Walk the length of the field, counting each time your right foot steps down. Or, just your left foot if you prefer.
- Divide 300 feet by the numbe of paces you took and that is your pace length.
- It is a good idea to repeat this in the other direction and take an average.

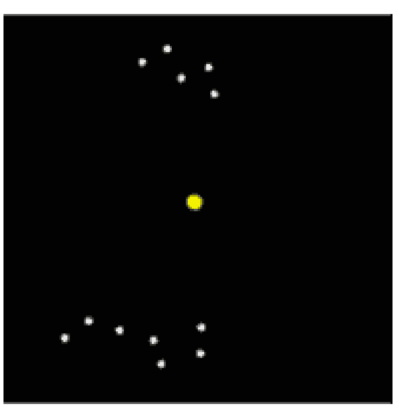
Now that you know your pace length, you can estimate how far you hike. As you hike along, keep track of your paces. At any time, you can multiply your paces by your pace length to figure how far you've travelled.
But, here's why I personally don't find it very useful:

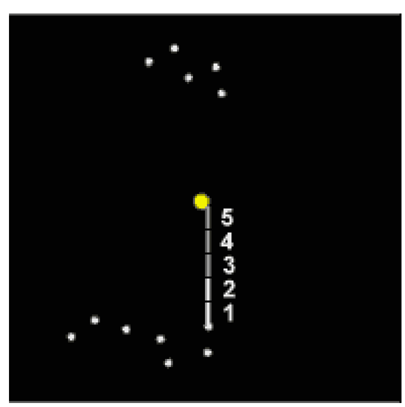
- Going uphill, downhill, across hill, through deep grass, over sand, through brush, over rocks all have an effect on shortening your pace.
- Wearing a backpack shortens your pace.
- Losing count of your paces means you go back and start over or guess and start again from your current spot.
- I'm in the wild to enjoy the wild, not count my steps.
- With my map and compass, I know where I'm going and about how far I have to go. I don't need to pace.

So, pacing is useful for competitions, for learning about how your body covers ground, and for doing specific distance estimating. It also may be useful if you ever become lost and have also lost your compass and map. In that case, you can estimate directions and then track how far you travel.

Finding Direction with No Compass
There are lots of fun ways to find directions if you've lost or forgotten your compass. They are great exercises to do just to learn them and have handy just in case or to impress your city-slicker friends. These methods can be used to map cardinal directions and better, but remember that they are not nearly as good as a compass.

Polaris the North Star
This is my favorite and the easiest one to do. All you need is a fairly clear night and knowledge of a couple constellations.





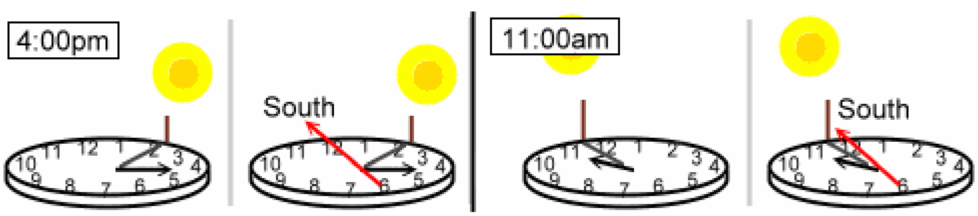
- Find the Big Dipper in the sky.
- Follow the edge of the ladle 5 times its length up the edge of the ladle.
- The brightest star there is Polaris the North Star which is virtually north.
- Cassiopeia is a 'W' shaped constellation across the North Star from the Big Dipper. It's 'W' points right at the north star also.
- In the southern hemisphere, the Southern Cross is used to indicate South similarly to Polaris.

All the stars in the sky appear to circle around Polaris. It is nearly right on the axis of the world which is true north, not magnetic north.

Watch Method

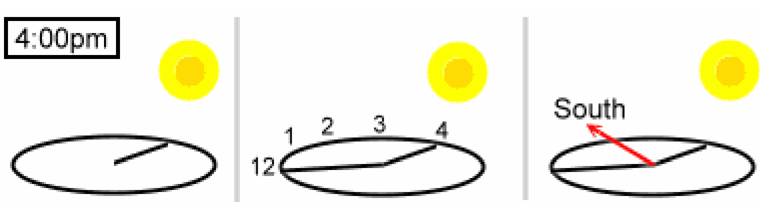
In the days of digital watches, this one is fading away.

- Hold your wristwatch in front of you like a compass.
- Hold a toothpick or little twig or piece of grass up along the edge of your watch so it casts a shadow toward the center of the watch.
- Turn your watch until the shadow splits in half the distance between the hour hand and 12 on the watch face.
- 12 is now pointing South and 6 is pointing North.
- In the southern hemisphere, 12 points North and 6 points South.



If you have no watch, use your imagination.

- Draw a big circle in the dirt with a stick.
- From the center of the circle, draw a line straight towards the sun. (this is your hour hand)
- Now, draw a line to 12 on the circle where it would be in relation to the hour hand.
- Halfway between the two lines is South.

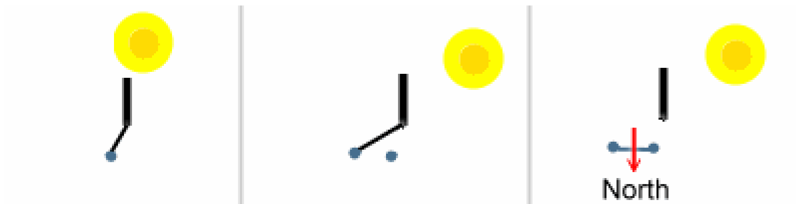


Sun Shadow Method

The sun moves across the sky from east to west and its shadow gradually changes in length which is what makes this direction finding method work.

- Clear a flat area of dirt or sand. Grass will work, but not as well.
- Find a stick about 2 or 3 feet long and stick poke it into the ground so it stands up.
- Get another small stick or pebble and place it exactly on the end of the shadow line.
- Eat a trail bar or relax for a half hour.

- Place another stick or pebble at the end of the new shadow. If you have time, wait another 1/2 hour and repeat.
- The line between the two pebbles runs east-west direction with the first mark being west and the second being east.
- If you are in the northern hemisphere, North direction is perpendicular to the east-west line heading away from the sun. It's South down under.

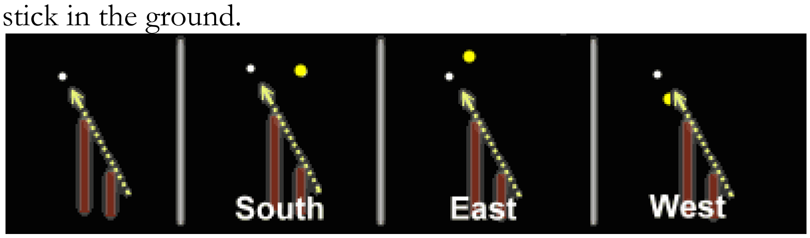


A cool variation on this is that it works well at night with a bright moon too!
There is a similar version that is more precise if you have a few hours to wait, but the difference in precision is not worth the wait - its mostly just for fun and takes two people.

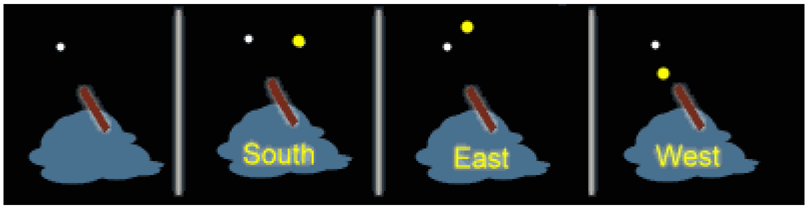
- Clear a flat area of dirt or sand. Grass will work, but not as well.
- Find a stick about 2 or 3 feet long and stick poke it into the ground so it stands up.
- Get a piece of string or rope or a stick that is the length of the current shadow.
- Have your buddy hold the string at the base of the shadow stick while you scratch a circle in the dirt around the shadow stick using the string as the radius guide.
- Go fishing, sleep, or waste the next hour or so.
- Check on the shadow and notice that it is shorter and has moved to the east. Continue to check the shadow until it is again long enough to touch the circle. This may take an hour or 6 hours, depending on how early you set it up.
- Drawing a line between the original shadow point and the current shadow will be West to East.
- If you are in the northern hemisphere, the cardinal direction North is perpendicular to the east-west line heading away from the sun. It's South down under.
- Any two shadow points the same distance from the shadow stick will make an east-west line.

Star Method
If you can't find the Big Dipper because it is behind a mountain, or behind clouds this method can help if you can see some stars in the sky:

- Two Sticks:
  - Find a tall stick about 3 or 4 feet high and stick it in the ground.
  - Sit on the ground by the stick.
  - Using another stick about 2 feet long, sight the tops of both sticks to a bright star and stick the shorter stick in the ground.



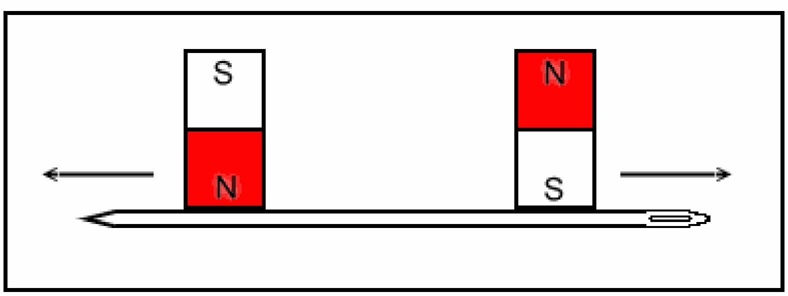
- One Stick:
  - Using a tent pole or other straight stick, position it on a tall rock or on a tree limb so it is steady.
  - Stand or lay in a position and location that you can copy later. A good example is laying against the rock with your chin on your fist and mark your fist location on the rock with chalk or a rock scratch.
  - Sight up the stick at a bright star that you can recognize later.



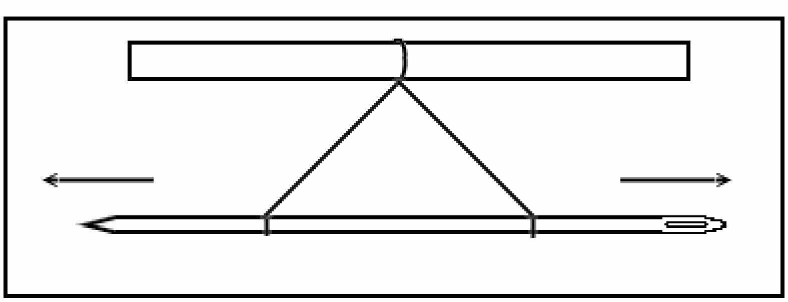
- Come back in a half hour and notice which direction the star has moved. You may want to check this at 15 minute intervals for an hour.
- If the star has moved to the right, you are facing south.
  moved Left = facing North
  moved Up = facing East
  moved Down = facing West
- The star will most likely have moved up and right or down and right so you will need to estimate the direction, such as SouthEast or SouthWest.

How to Make a Compass
If you happen to be out on a trek and realize that you forgot your compass but happen to have a magnet and a needle or nail in your pocket, I'll tell you how to make a compass. Chances of this ever being used in a real situation are slim, but it's a fun thing to do just so you know how to do it.

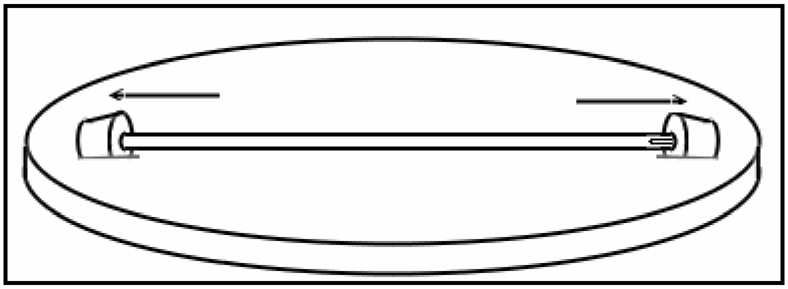
- Get a big sewing needle or a very small nail and a bar magnet. Also get some thread or a bowl of water and two tiny pieces of cork.
- Hold the needle in one hand and the magnet in the other.
- Put the North end of the magnet against the needle in the middle and rub it towards and off the point.
- Lift the magnet up and away from the needle and place it in the middle again.
- Repeat rubbing the North end of the magnet against one half of the needle 20 times or so.
- Flip the magnet over so you are using the South end and rub it from the middle to the 'eye' end of the needle 20 times.
- You have magnetized the needle just like a compass needle.



- Hanging Compass:
  - Tie one end of a length of thread to a stick and the other end to the middle of the needle. Or, tie it like the image for easier balancing.
  - Let the needle hang freely and slide the thread to a point on the needle where it balances level.
  - Lower the needle into a wide-mouthed jar and lay the stick across the opening to prevent wind interference.



- Floating Compass:
  - Stick a tiny piece of cork on each end of the needle so it floats.
  - Place the needle on the water in a small bowl.
  - Wrap a layer of plastic wrap over the bowl to prevent wind currents for better accuracy.



- Watch which way your compass needle turns. It should always settle to the same direction.

And that is how to make a compass - it's actually a quick history lesson in how the earliest compasses came about as well.

This is the last page in my map and compass tutorial. If you've started at the beginning and gone through the whole thing, you should have a good idea about how compasses work and how maps help us along the way. I hope you've enjoyed your trek. I also hope you take a shot at finding cardinal directions and Polaris the north star and let me know what worked for you.

Now, you just need to go practice and plan your next excursion out of your cubicle, away from your computer screen, and into the real world that's waiting out there!

Source: http://www.compassdude.com