
THE SITE EVALUATION KIT

HOW TO UNDERSTAND YOUR LAND & PLAN A SUNNY HOME

- **How to chart the local sun path and design for your site**
- **How to build a bright warm home inexpensively**
- **How to modify standard plans for solar efficiency**
- **A solar property guide for all 48 U.S. mainland states**
- **Climate and sun maps for local "tweaks"**
- **Includes build-it-yourself solar inclinometer**
- **Using the inclinometer to survey your land**



A solar saltbox farmhouse with attached sunroom

By John Raabe

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Isn't a Solar Home something from the 1970's?

Solar energy is often seen as exotic. Nothing could be further from the truth. The basics have been understood for thousands of years.

Simple solar strategies involve building the house in the right place on your land and putting the rooms and windows in the best locations to take advantage of that light and warmth. These "solar features" cost nothing to build into a new house. Ignoring them not only costs money in terms of higher heating bills for the life of the house, but it condemns the house to be darker, damper and less inviting than it could be.

There are two main approaches to using solar energy:

- **Passive Solar** involves the way the home is designed and how it lets the sun in and holds the resulting heat. This is what this booklet is about. This is an architectural or planning solution.
- **Active Solar** is an engineering or hardware solution where collectors convert sunlight into another form of energy (usually hot water or electricity) and store it somewhere for later use. Active solar is beyond this book, but the sunchart you produce here will be helpful in determining the location and suitability of collectors for your site. Solar electric collectors are quickly becoming realistic options for remote building sites. (See www.backwoodssolar.com.)

This booklet will help you find the best place on your property to build a sun-filled house. It will give you construction ideas for low-cost uses of solar. This is smart solar and simple solar. Do the easy stuff first. Later, you can go further if you wish.

May the sun shine on all your projects,



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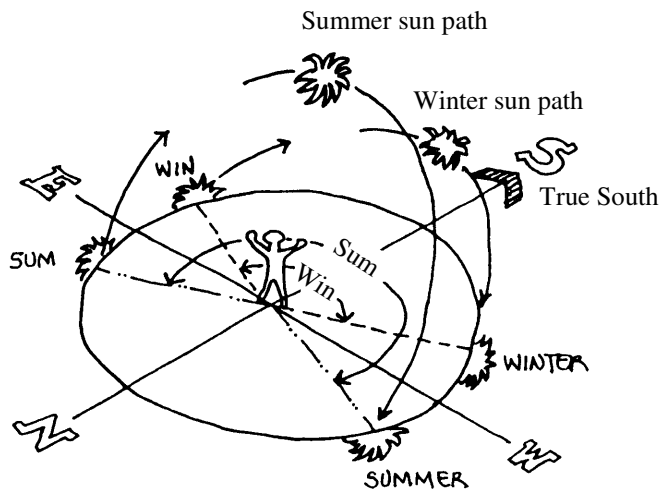
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The Solar Site Survey

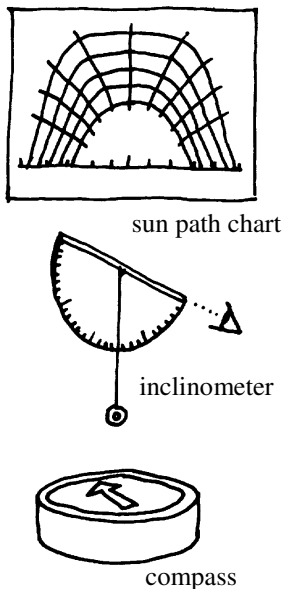
One of the first things that you want to find out about a prospective house site is how the sun will move across it. How much sun your house will see and what rooms it will light up will determine in large part how the house feels. It will also make a big difference in your heating bill. Don't think that just because



The yearly path of the sun

the building site is sunny when you see it that it will be sunny all year long. The difference between the summer and winter sun path is considerable. The further north you travel the greater the difference.

The only way to know for sure what sun you will get at your site is to plot the solar blockage and put it down on a sun chart appropriate for your latitude. This will let you see exactly what times of the year and what times of the day the house will see the sun.



The three tools of a solar survey

Even on a site with good sun for three seasons — plenty for gardens and a yard — a solar site survey can allow you to fine tune the best location for the house and thereby brighten many a dreary winter day.

A sun chart is not needed if you have a site that is unobstructed down close to the horizon for 90° either side of true south. You will get all the sun possible for winter heating. You will want to do a sun chart if your site is more closed in than that, or if you want to control the sun during certain times of the year.

You need three tools to do a solar survey: a sun path chart for your latitude, an inclinometer to measure angles relative to the horizon, and a compass to locate true south and the angles east and west of it. The chart you need and the main parts to make an inclinometer are included in this kit. You supply a hiking compass.

How to assemble and use the Inclinometer

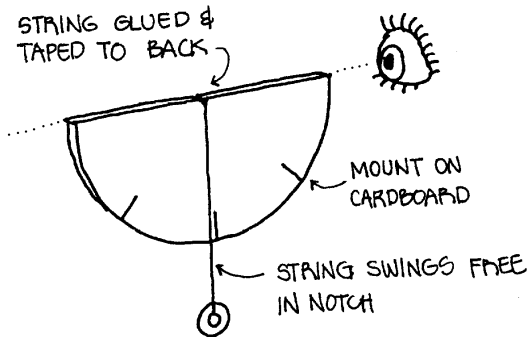
The inclinometer is a very helpful multi-purpose tool for evaluating property. To assemble this item you will need a few tools — an adjustable razor knife with a sharp blade, rubber

cement or spray adhesive, a metal straightedge or ruler, and some white glue. In addition, you will need a few small items you can probably find around the house — part of a cardboard box, about 9" of heavy thread or light twine, a nut or washer, and a bit of electrical or duct tape.

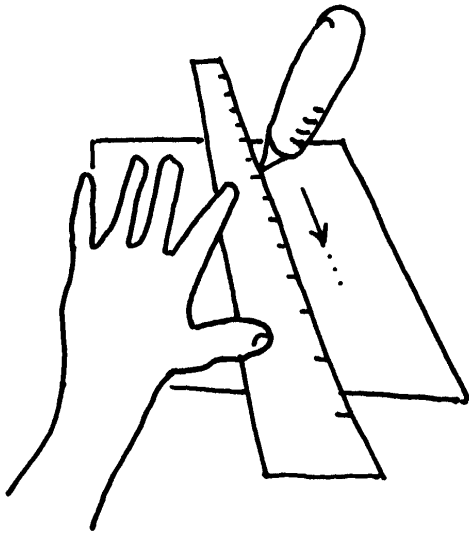
Start by cutting out the inclinometer half-circle from the template on page 18. Cut it out with scissors and make it a little larger than final size. Don't cut too close to the lines. You will trim them later. Coat the back

with rubber cement or spray adhesive and press it down onto a piece of clean corrugated cardboard somewhat larger than the inclinometer. Set it aside to dry.

Now get the string set up. You need some kind of weight to tie to the bottom of the string. A 3/8" nut will work great, but a heavy washer or a 10-carat diamond ring will also work. Tie this securely to the end of your thread.



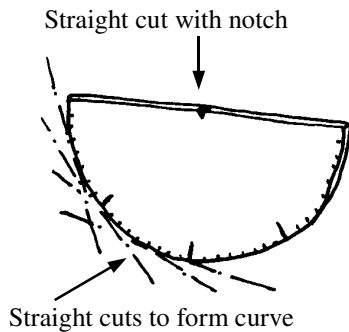
The home built inclinometer



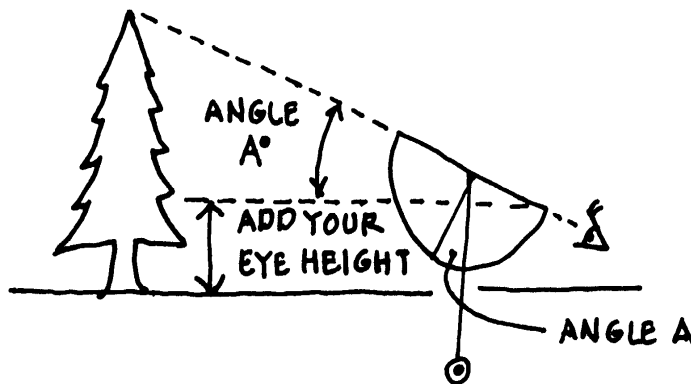
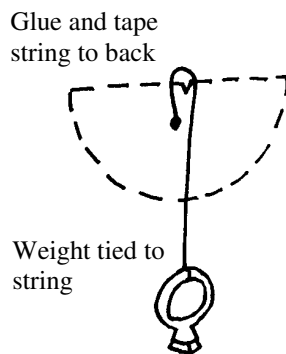
Keep a sharp blade and a steady hand.

Tricks and techniques of using a razor knife

Go back now and trim the inclinometer. The top edge should be very straight, as you will be sighting along this to line up the object you will be measuring. Cut slightly above the line using a metal straightedge. Keep the razor knife vertical and draw it smoothly along the metal edge.



Inclinometer shape glued to cardboard and cut out with razor



Using the inclinometer

You don't need to use much pressure and you don't have to cut all the way through the cardboard in one stroke. If you keep the straightedge in position with the knife vertical you can make several light cuts in the same groove and work your way down through the heaviest of materials. This is how you cut heavy cardboard and poster board.

Next, cut away the bottom half of the circle. This is best done as a series of straight cuts — this way you are less likely to crush the cardboard edges. The bottom does not have to be round.

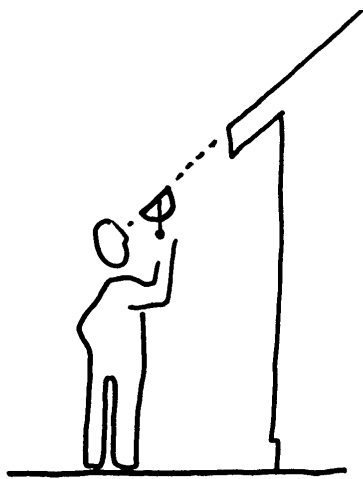
When you have the shape the way you like it, make a small triangular notch at the mid-point of the straight top of the inclinometer. This is where the string will sit. Don't cut this notch too deep. The string needs to pivot freely from the exact center point of the circle.

Finally, cut the length of your weighted string so that it hangs about three inches below the bottom of the inclinometer. Tie several knots at the top of the string and run it over the notch and lay it on the backside of the cardboard. Put a drop or two of glue on the knots and cover it with a small piece of tape while it dries. The weighted string should swing free in the notch and read angles as the inclinometer is tilted. When everything is dry you're ready for a shakedown cruise.

Testing the Inclinometer

To use the inclinometer, you sight along the top and use the string to measure an angle between what you are aiming at and the horizon line — or more precisely, a horizontal line that is at your eye level above the ground. When you sight along the

top of the inclinometer let the weighted string swing lightly against the side until it stabilizes. As it does, place a finger lightly on the string to hold its position while you move it away from your eye to read the angle. Let's try it out.



Sighting the angle of the roof.

Pitch	Angle
2" in 12	9.5°
3" in 12	14°
4" in 12	18.4°
5" in 12	22.6°
6" in 12	26.6°
7" in 12	30.3°
8" in 12	33.7°
9" in 12	36.9°
10" in 12	39.8°
11" in 12	42.5°
12" in 12	45°

Note:

To do an accurate survey, you will need a compass with degree marks and a rotating ring for angle adjustments. A hiking compass works well.

Measure the pitch of your roof

Go outside and measure the pitch of your roof. Find a place where you can stand and look straight up the roof slope. This will be a point where your eye is in a straight line with the angle of the roof. Measure this angle with your inclinometer and then find the roof pitch in the chart of roof angles. It will most likely be an angle that matches a carpenter's pitch such as 4:12 or 6:12 (inches rise per inches run).

See the section C report on "Using the Inclinometer to do Simple Surveying" for more uses of this simple tool. You can use the inclinometer to measure the height of trees or buildings, determine the slope of a road or find the height of a foundation wall at your building site.

Plotting a Sun Chart

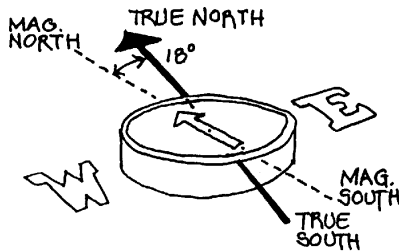
Now let's use the inclinometer and the appropriate sunpath chart to plot the available sunlight at your house site.

First we need to find the right chart. See the map on page 11 and locate your site. The map shows the magnetic declination and latitude for your site. There are sunpath charts for each of the numbered latitude lines (running east west) shown on the map. Find the one that is closest to your location and make a working copy. Keep the master so you can use it again. Also get out your compass and we will adjust it for your location.

Magnetic North Vs True North

Before going out to the site with your solar tools you need to find the true north/south line. It would be great if you could trust your compass; however, the north pole (at the centerline of the earth's rotation) and the magnetic pole (where the compass needle points) are not at the same place. The magnetic pole actually moves around and is the product of a series of complex relationships involving earth's molten iron core and

the speed of rotation. For our purposes, use the heavy dotted lines on the declination map. This line shows the difference between the two poles (magnetic and true) as an offset angle — the number of degrees you need to dial into your compass to compensate for the difference.



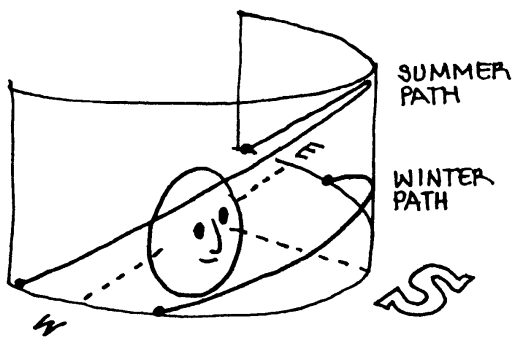
Magnetic Declination diagram for central Maine, offset 18° W.

Notice the 0° line running from Michigan to Florida. If you happen to be close to this line you are magnetically neutral and don't have to worry about offset angles. If you are east of this line your compass points to the west of true north. If you are west of the line your compass will point east of true north.

How do you really use this information? Fortunately, it's easier to do than it is to explain. Let's take the example of central Maine. Looking at the map we see the declination is 18° W. That means the compass is pointing 18° W of true north. True north is 18° east of compass north. True south (which is what we are interested in) is 18° west of compass south.

This is the part to remember — **whatever the map has as your declination, is the angle you dial into your compass to find true SOUTH.** Our Maine resident would get the compass to stabilize and starting at the south tip of the compass needle, rotate the adjustable pointer dial 18° west to find true south. If you are in the Western U.S. you will be rotating the dial to the east.

Reading the Sun chart



Wrap the chart around your head with your eyes at the horizon line.

This new location is local **True South** and is where you start plotting the sun chart. You may want to note this on the inclinometer to remind yourself of this angle when you go out into the field.

Get out a sun chart for the closest latitude to your site. Looking at the chart, notice the bearing angles at the bottom. These are compass angles to the east and west of true south. Face true south and put the chart up to your face. Imagine it is large enough to wrap around your head with the bottom line at your eye level. Off your right ear would be 90° due west, and off your left ear is 90° due east. The altitude angles along the right side of the

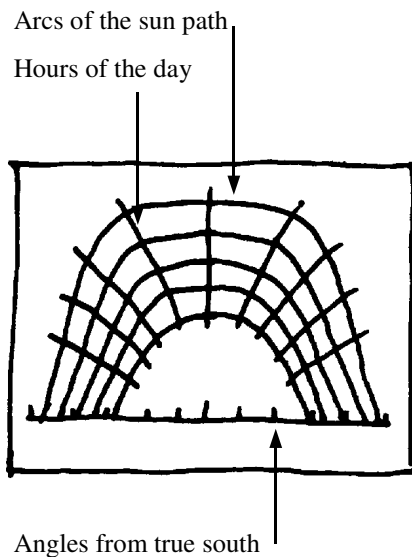


chart are degrees above the horizon. This is what you will be measuring with the inclinometer.

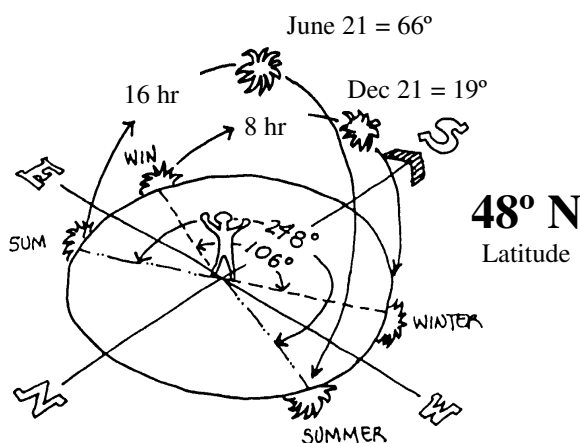
The arcs are the paths the sun takes through the sky on the various dates that have been plotted. It is lowest in the sky on December 21st. From there it starts back up rising further north each morning, tracing a higher arc in the sky and setting further north each evening. This lengthening day process goes on until June 21st when the sun carves its widest arc and reaches its highest point in the sky. Then it starts the same process the other way tracing smaller and lower arcs each day until the next December 21st.

The only other thing we need to explain about this chart is the dotted lines that are perpendicular to the sunpath arcs. These are the hours of the day in standard time. (They will be an hour earlier than local time during daylight savings time.)

Understanding this chart and facing true south you should now be able to point in the sky to the approximate place the sun will be at 11 am on April fools day. If you are at your building site, and your goal is to have a sunny bright house, then I hope you are pointing to open sky!

When you are after usable solar energy for home heating, you are primarily interested in the sunlight you will get between 9 AM and 3 PM during the heating season — typically October through April or May. Before and after those hours the sun is too low in the sky to have much heat content. In the summer, however, late

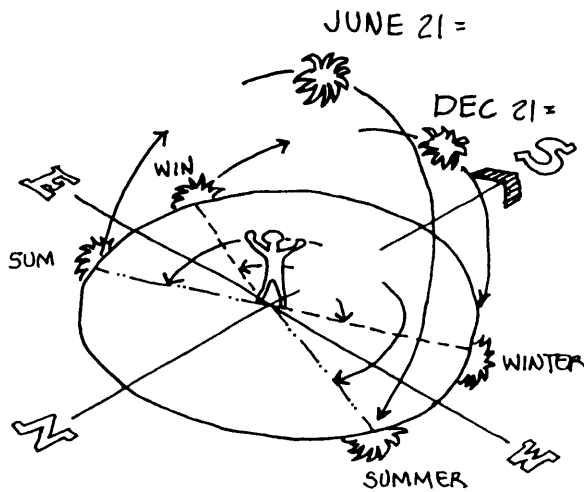
afternoon sunlight can come in almost directly through west facing glass. You may want to plant some trees or otherwise block this afternoon summer sun. In hot climates, you may even wish to block morning light from the east during these months.



Look at the sun path diagram at the left. It was made from information on the chart for 48° N latitude. There, on Dec. 21st the sun rises about 8 AM and sets around 4 PM. That's eight hours of potential sun. In winter, the sun comes up in the SE and goes down in the SW.

In summer it rises in the NE, sets in the NW, and spends about 16 hours in the sky.

Using information from the sun chart for your latitude, make a similar diagram for your own site. Fill in the blanks on the graphic below. You can make copies of this diagram and tape one to your site plan or floor plan.



Sun path and site information for _____ N latitude
True south is _____° _____ of magnetic south

You can also add other information. Show the direction to your best views. Where do the winter storms and summer breezes come from? Is there a view to a neighbor's house or headlights coming from the road? This little graphic can give you a lot of information about your site in an easy to remember way.

Charting Solar Blockage

Now it's time to put these tools to work. Locate a position midway along the south face of your real or proposed house site. Stabilize the

compass and determine your true south orientation. Use your inclinometer to measure the angle to the top of whatever is highest in the sky looking due south.

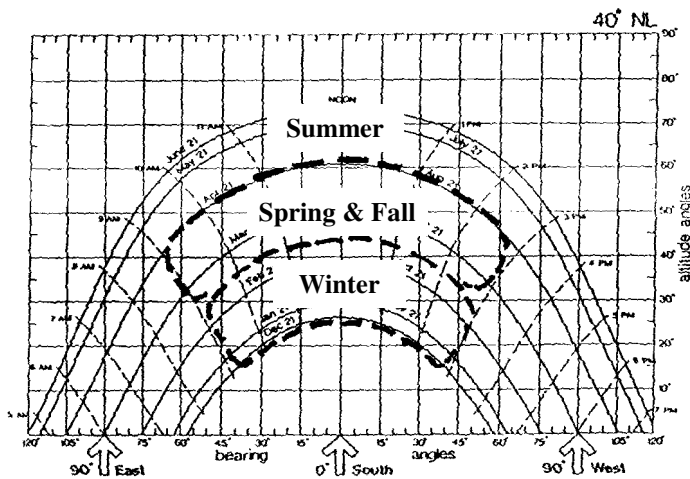
Plot this blockage angle as a dot on the vertical line marked "0° South." The altitude angles on the right side of the chart are the angles from the inclinometer. Do the same thing for each 15° increment on the chart. Use your compass to locate these angles as you move east and then west of true south.

When you've plotted all the points on the chart, connect the dots with a solid line. This is the line of solar blockage at your site. The areas above this line are the times of the year when this site will have clear access to the sun.

If you've measured the tops of deciduous trees that will lose their leaves in winter, then plot a second dotted line to represent the blockage when the trees are bare. The difference between the two

lines will be the extra sunlight your site will receive in winter. Note your estimate of blockage by bare branches (typically, 25-45%).

You might want to do another plot from a different location or from a different floor as the house goes up. If the sun is blocked by nearby trees or buildings, the second floor will see considerably more light for more of the day. If your blockage is further away, mountaintop say, then there is little advantage to going higher.



Seasonal sections of the sun chart

What is a "good" solar chart?

You now have a chart with the blockage of the sun at the building site. How do you use this information? First look at the sun's seasonal pattern.

Winter (the lower section of the chart) — Good light during this time of the year is

appreciated anywhere in the U.S. Blockage in this section will tell you which trees to cut. Plan your own plantings so they don't block this section of the chart.

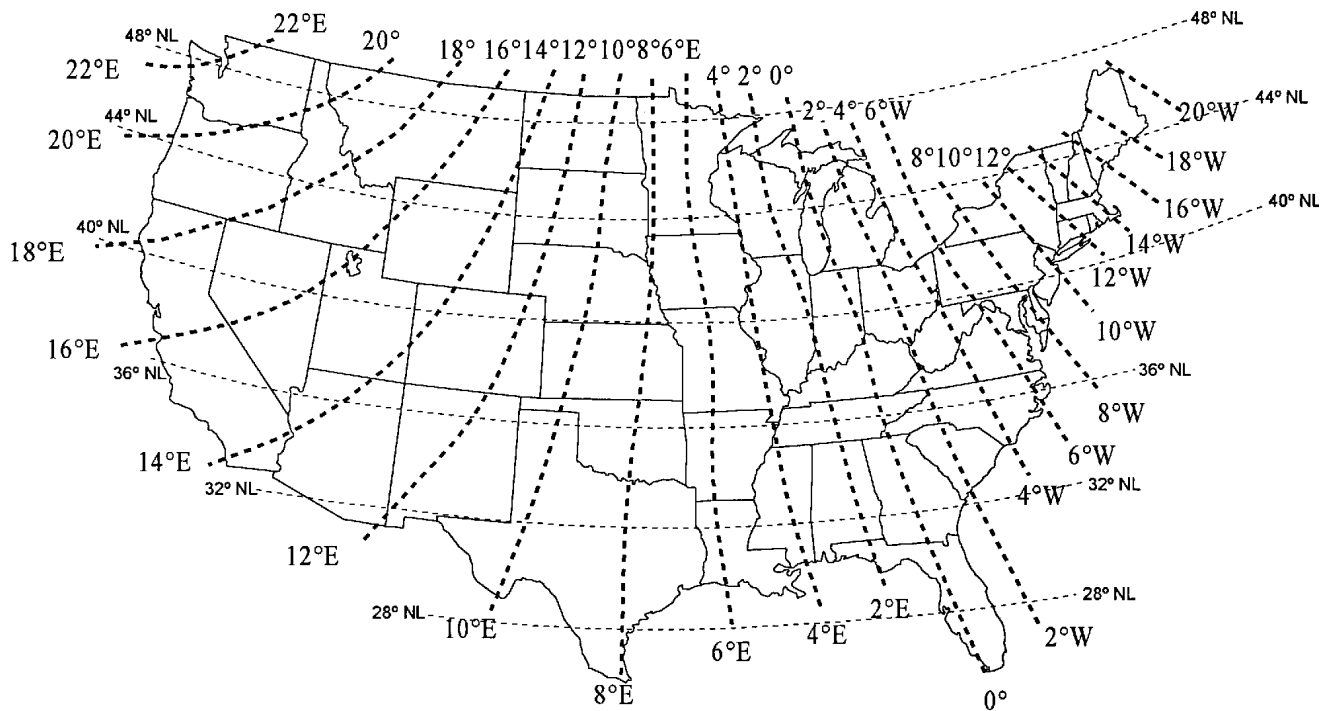
Spring and Fall (middle section of the chart) — For much of the North this is when solar heating will be most effective. (Winter sun in Northern states is usually too low in the sky and the days too short to have much heat content. In Spring and Fall, however, the sun is higher and the days longer; yet a Northern home will still need heat.)

Summer (top of the chart) — In many places, blockage of summer sun, particularly from the the west will keep the house cooler. You may wish to leave or plant deciduous shade trees that can block this low angle western sunlight.

Now, look at the sun patterns during certain times of the day.

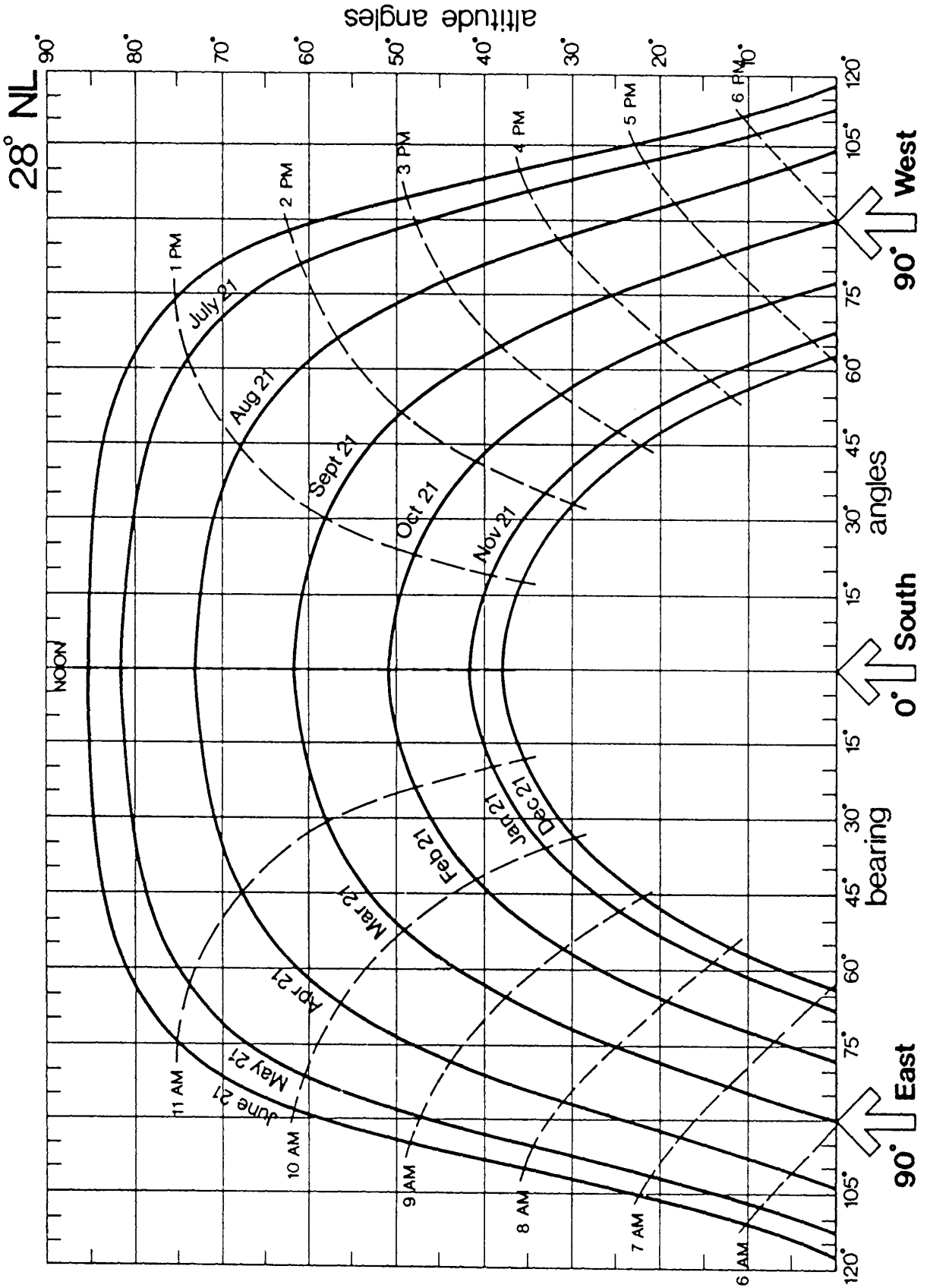
Here are some questions to answer.

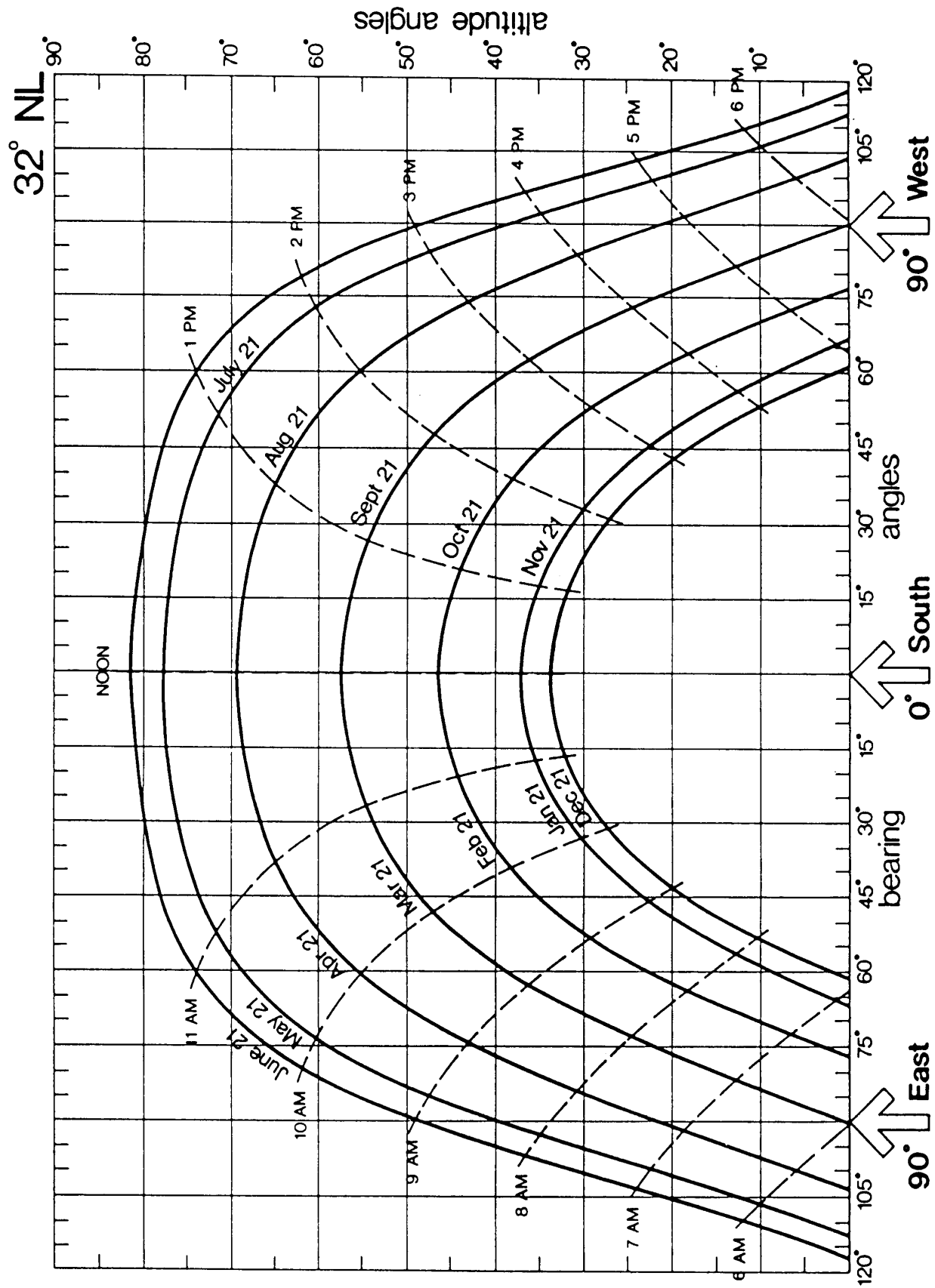
- What times of the year is the morning sun blocked?
- If you put your breakfast table in the SE corner of the house, will the sun be hitting your face when you sit there at 6 AM on a Spring morning? When will you see it?
- If you put the stairway on the north side of the house, can you see a summer sunset out the landing window?
- Where would a porch be most appreciated for its summer shade?
- Where should trees or other landscaping plants be located to help control sunlight during the summer?
- Are the major rooms of the house getting the right amount of light during the right times of the day?
- Where would be the best place to plant a kitchen garden or flowers close to the house?

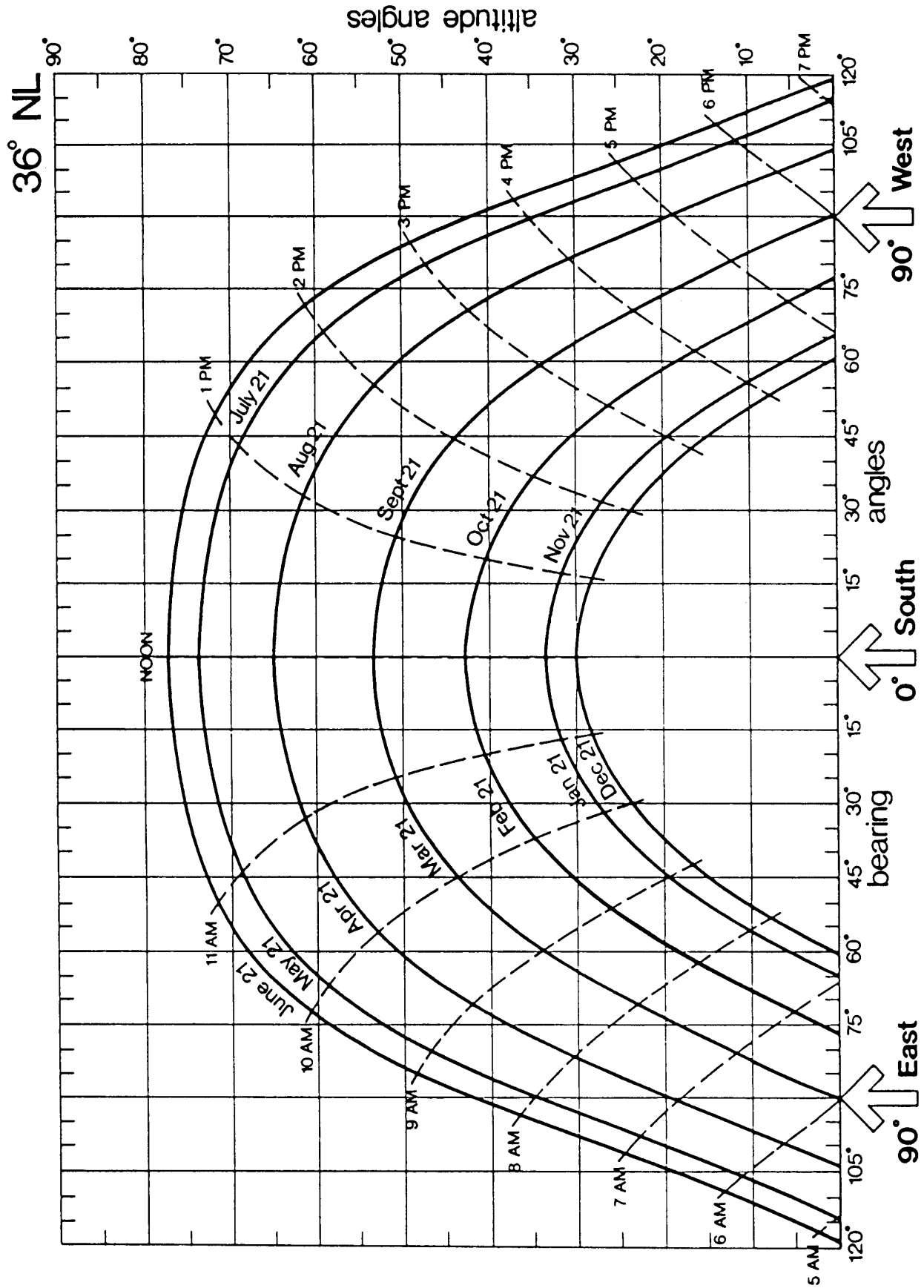


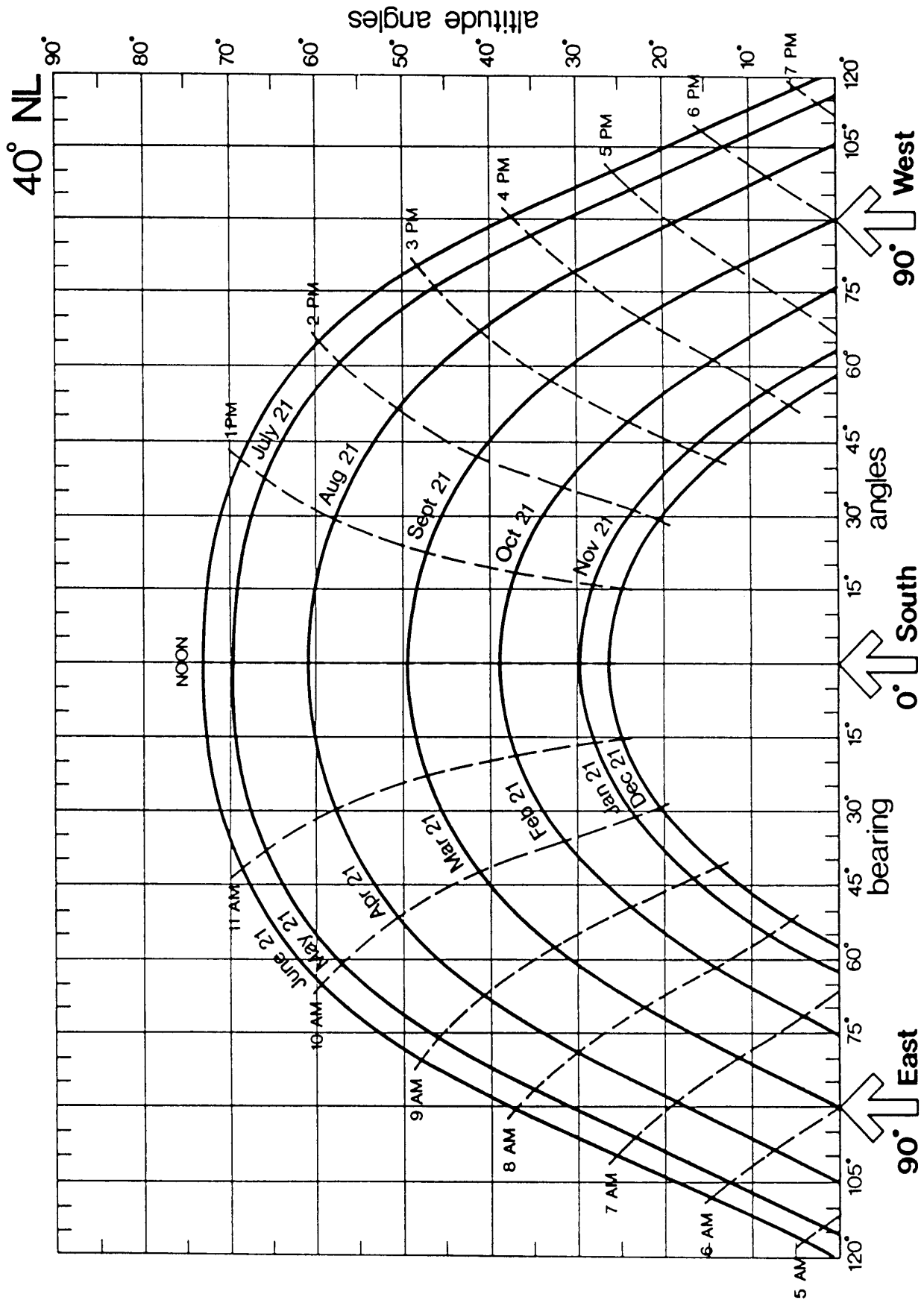
Magnetic Declination Map

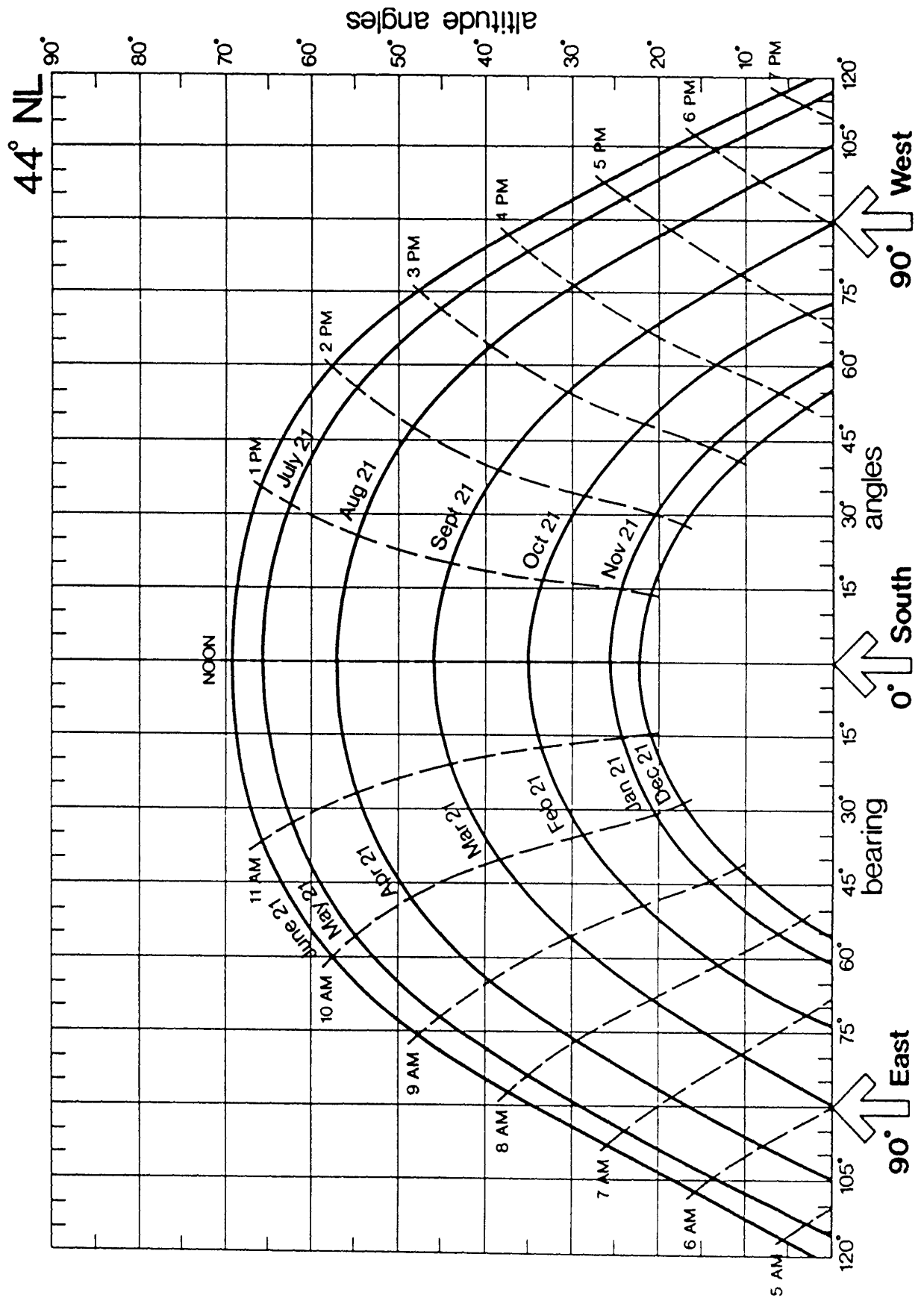
Sun charts on the following pages are from "The Passive Solar Energy Book" by Edward Mazria. Used by permission of the author.

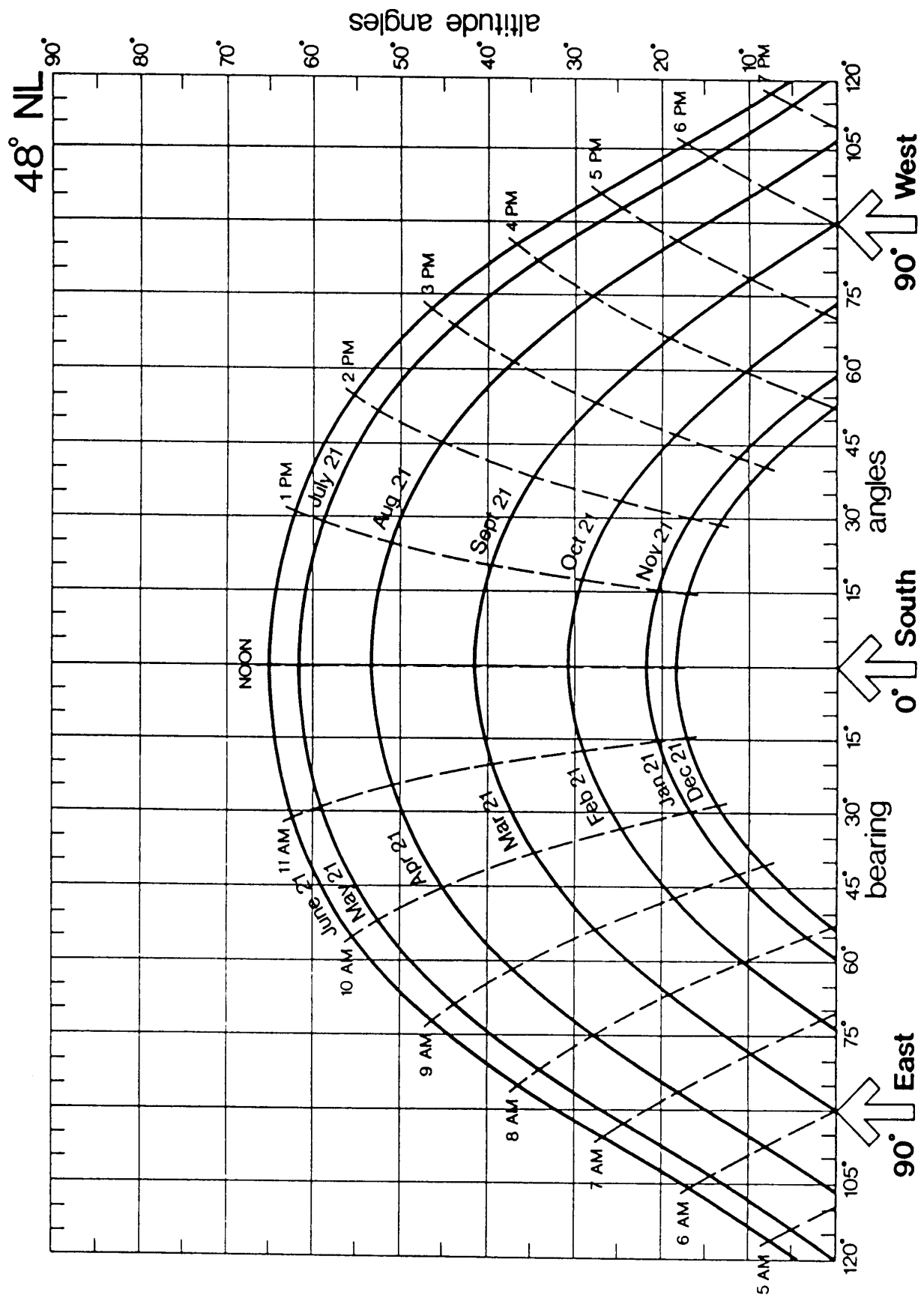


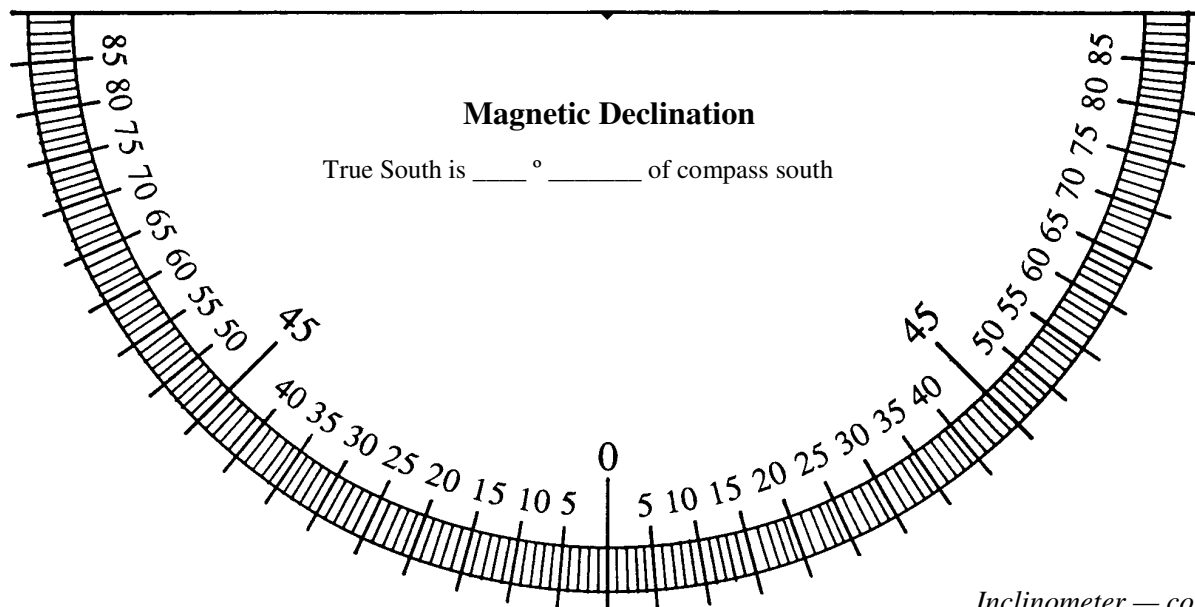




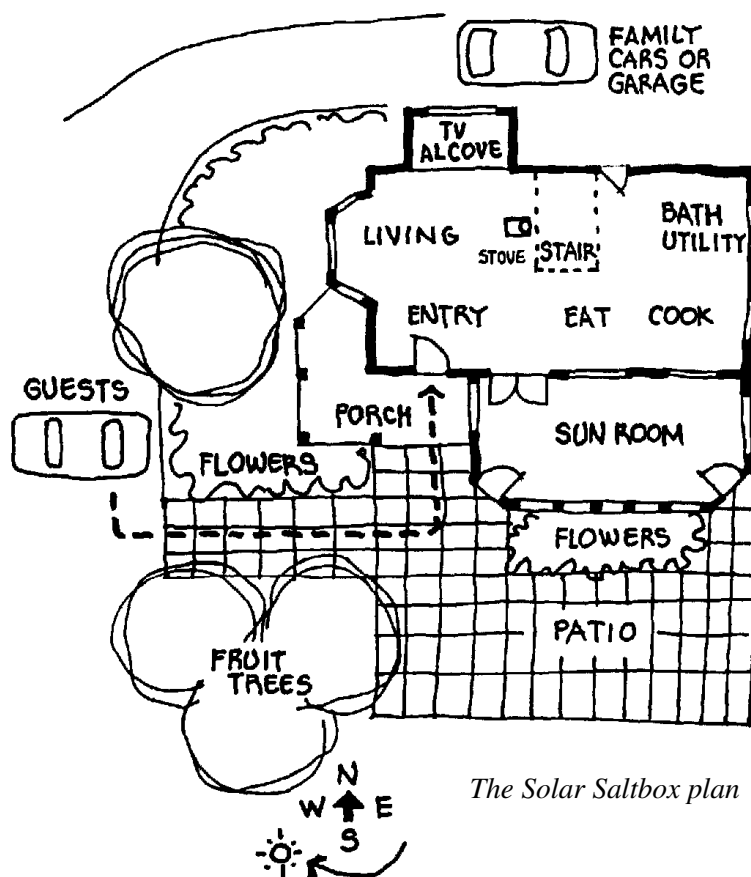








Inclinometer — copy onto card stock and cut out.



Here's an example of a Northern house laid out for the sun. The kitchen and eating areas are in the S-SE. The Living Room looks west. The bath, utility and stair are towards the north since they have less need for good natural light. The carport/garage is behind the house and out of sight of guests.

Guests are brought through the landscaping and up onto the porch before reaching the door.

This house would also work well if the sunroom were eliminated and the patio extended up to the french doors off the eating area. Sun would come directly into the house during the heating season rather than warming the sunroom.