LATITUDE FORMULA FOR 1:24000 SCALE WITH 2.5' TICK MARKS

Distance in mm from nearest latitude line to location x 150_____ = seconds of latitude
Distance in mm between latitude 2.5' tick marks (along the sides)

If seconds > 60, convert to minutes and seconds. If measured from top latitude line, subtract computed value from top latitude line value. If measured from lower latitude line, add computed value to lower latitude line value.

LONGITUDE FORMULA FOR 1:24000 SCALE WITH 2.5' TICK MARKS

Distance in mm from nearest longitude line to location x 150_____ = seconds of longitude
Distance in mm between longitude 2.5' tick marks (along top or bottom)

If seconds > 60, convert to minutes and seconds. If measured from left longitude line, subtract computed value from left longitude line value. If measured from right longitude line, add computed value to right longitude line value.

LAT / LONG WITH OTHER TICK MARKS

If the topographic map is in a scale other than 1:24000, then the L/L tick marks will be for minutes other than 2.5. Change the 150 multiplier to 300 for 5' tick marks, 450 for 7.5' tick marks, 600 for 10' tick marks and 900 for 15' tick marks.

WRITING LAT / LONG

Express latitude first with an N at the end (if in the US). Longitude second with a W at the end (if in the US). Always include degrees. Include minutes and seconds if they are not zero. If you have zero minutes but some seconds, include 00'. Degrees can be 1, 2 or 3 digits. Best practice is two digits for latitude and 3 digits for longitude with leading zeros as needed. Minutes and seconds are always two digits with a leading zero if needed. Include °, ', ", or the words as needed. E.g., 42° 44' 55" N, 86° 27' 38" W. If in the continental US, latitude degrees will always be smaller than longitude degrees.

PLSS

Read and write the data from right to left (backwards). E.g., read SW ¼, NE ¼, S14, T05N, R37E as range 37 east, township 05 north, section 14, northeast ¼, southwest ¼. You may see a third level of quarter sections. When writing a PLSS description, start with Rxxz on the right, then Txxy to the left of Range, then Secxx to the left of Township, then yz ¼ or (y or z) ½ to the left of Section, then yz ¼ or (y or z) ½ to the left of the quarter section. If you are describing a ½, use only one letter, N, S, E or W, as appropriate. Use commas to separate the elements (e.g., N ½, SW ¼, NE ¼, Sec14, T05N, R37E). xx = numbers, y = N/S, z = E/W.

PLSS **Sections** are **NOT** the same as **Sectors**.

Quarter section = 160 acres
Quarter-quarter section = 40 acres
Quarter-quarter-quarter section = 10 acres

Section = 640 acres or 1 square mile (1 mi^2)
Acre = 43,560 sq ft = 208.71 feet on a side

UTM

The numbers along the top and bottom neatlines (e.g., ^{5}59) are an east-west position in kilometers, called an **easting**. The numbers along the right and left neatlines (e.g., ^{42}82) are a north-south position in kilometers, called a **northing**. Use the phrase "**Read right up**" to help you remember to read the easting meter value from left to right first, followed by the northing meter value from the bottom up. Measure the meters from the left and bottom sides of the 1 km square around the point or use the UTM map tool. Start in southwest corner of square for both kilometer and meter coordinates.

WRITING UTM COORDINATES

Typical coordinates will look like 559741 m E, 4282182 m N. Meter form is xxxxxx m E, xxxxxxx m N. Kilometer form is xxx.xxx km E, xxxx.xxx km N. If a zone number is provided, write it in front of the coordinates, e.g., Zone 10S, xxx.xxx km E, xxxx.xxx km N. Use leading zeros as needed to maintain the correct number of digits.

The coordinates can be abbreviated as in the table. The 100m format (597 821), and the 10m format (5974 8218) are most common. You do NOT need to add m E/m N or km E/km N if you are using abbreviated format. Do NOT round up as you will end up in the wrong square. Use only if the question asks for the answer in abbreviated form.

59 82	Describes a 1000m x 1000m square
597 821	Describes a 100m x 100m square
5974 8218	Describes a 10m x 10m square
59741 82182	Describes a 1m x 1m square

STREAM GRADIENT OR SLOPE FORMULA

Mnemonic is "**Rise Over Run** Times Multiplier"

(End elevation – start elevation) (in feet or meters) x multiplier = +/- XX feet or meters per multiplier
Distance covered (in feet or meters)

Multiplier is the distance for comparison. E.g., feet per 1000' or feet per miles or meters per kilometer. Make sure the multiplier is in the same units as you measured. E.g., convert per mile by using 5280' for the multiplier if you measured the change in elevation in feet.

Default land or man-made features slope is feet per 100 feet or meters/kilometer
Default stream gradient is feet per 1000 feet or meters/kilometer

You need to know the starting point and ending point to determine the correct sign of the slope. Downhill slope or stream gradient is a negative number, uphill is positive.

Distance to measure is actual distance of road, line or stream. If they curve, measure the curve distance, not a straight line between ends.

WRITING SLOPE AND STREAM GRADIENT Signed computed value and per or slash the distance being compared, e.g., -10.27'/100' or -10.27 feet per 100 feet. Don't forget units.

DECLINATION, MAGNETIC AND GRID

Mnemonic is "**West is best, East is least**"
Add West declinations when going **from True** bearings/azimuths **to Magnetic** bearings/azimuths, and **subtract East** declinations. Predictably, do the opposite if going from Magnetic to True.

East declination is positive, west declination is negative
To calculate magnetic bearing from true bearing:
True bearing – magnetic declination = Magnetic bearing
To calculate true bearing from magnetic bearing:
Magnetic bearing + magnetic declination = True bearing.

Grid declination is the difference between the UTM grid and True North.

WRITING MAGNETIC AZIMUTHS AND BEARINGS – Add an M at the end, e.g., 021° M. Best practice is to add a T to true north azimuths and bearings. In Road Scholar, they are assumed to be true north unless otherwise directed. That is rarely the case in most real-world applications.

AZIMUTHS and BEARINGS

If doing azimuths or bearings, check to make sure which it is. ALWAYS double check the From and the To.

When measuring azimuths, having the protractor aligned to the north is critical for accuracy. Best is a longitude line or a latitude line to set the protractor on. Next best is the UTM grid, if they have it. You can use township lines or roads (if they are very N-S) to set the protractor on. Otherwise, do your best to make sure the N/S axis is straight up and down. Set the ruler between the two points. Move the protractor along the ruler until the center of the protractor is on your N/S reference and the edge of the ruler. Then read the azimuth. The azimuth must be read in the direction of the From object to the To object.

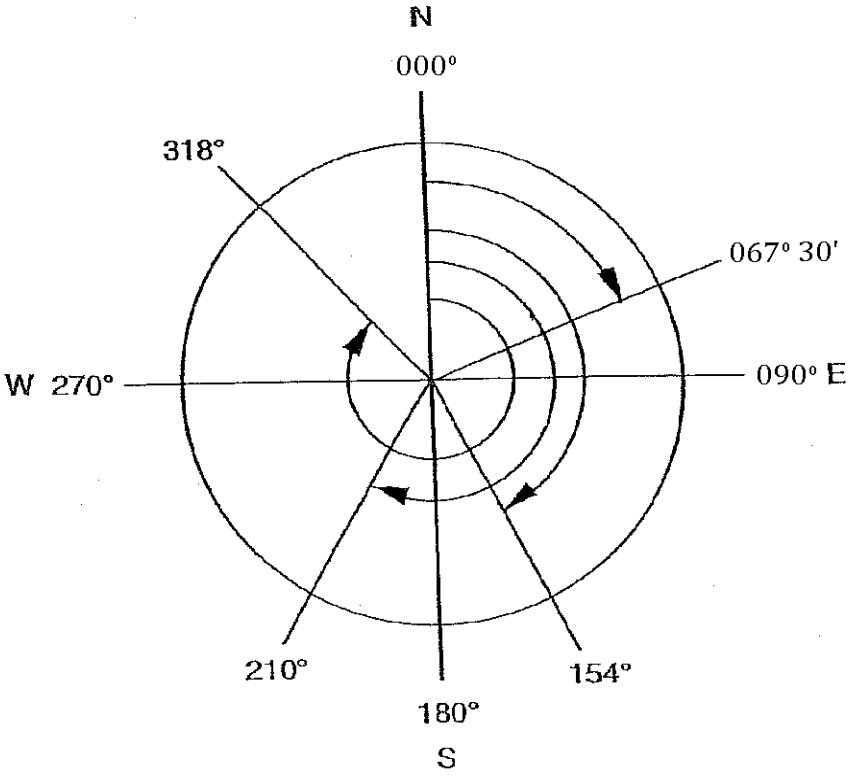
Bearings have two directional letters. They start with either N or S and end with E or W. E.g., N 27° E or S 38° W. If you are reading or writing a bearing, read or write right to left (backwards). E.g., west 38 degrees from south. This is similar to PLSS.

If you have to apply a bearing that you have been given between two points, convert it to an azimuth first, then apply the azimuth. If you have to find a bearing between two points, find the azimuth, then convert it to a bearing.

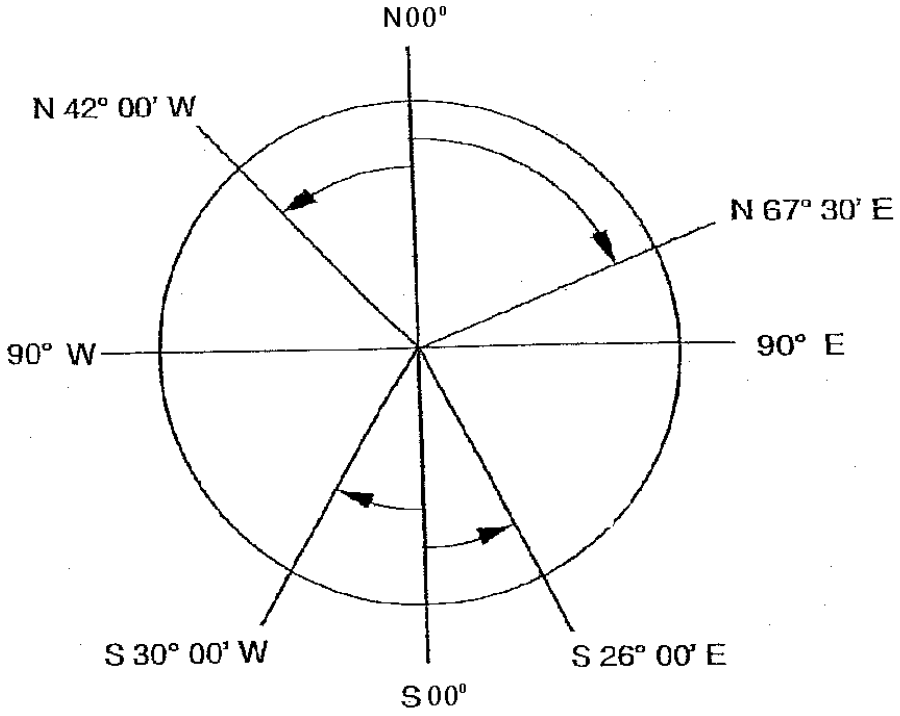
AZ 000° - 090° = BRG N 00° - 90° E Bearing degrees are the azimuth degrees but two digits
AZ 091° - 180° = BRG S 89°- 00° E Bearing degrees = 180 – azimuth degrees
AZ 181° - 270° = BRG S 01°- 90° W Bearing degrees = azimuth degrees - 180
AZ 271° - 000° = BRG N 89°- 00° W Bearing degrees = 360 – azimuth degrees
Exact N, S, E or W bearings can be written as N 00°, S 00°, 90° E or 90° W respectively.

Both azimuths and bearing can have minutes and seconds or fractions or decimals. E.g., S 60° 13’ 27” E or S 27 ½° W or N 28.5° W.

<u>WRITING AZIMUTHS</u> – Begin at 000° and continue clockwise to 359° 59’ 59”. Use three digits for degrees, e.g., 002°, 031°, 121°. Use two digits for non-zero minutes and seconds. Must have minutes if you have seconds, even if 00’.

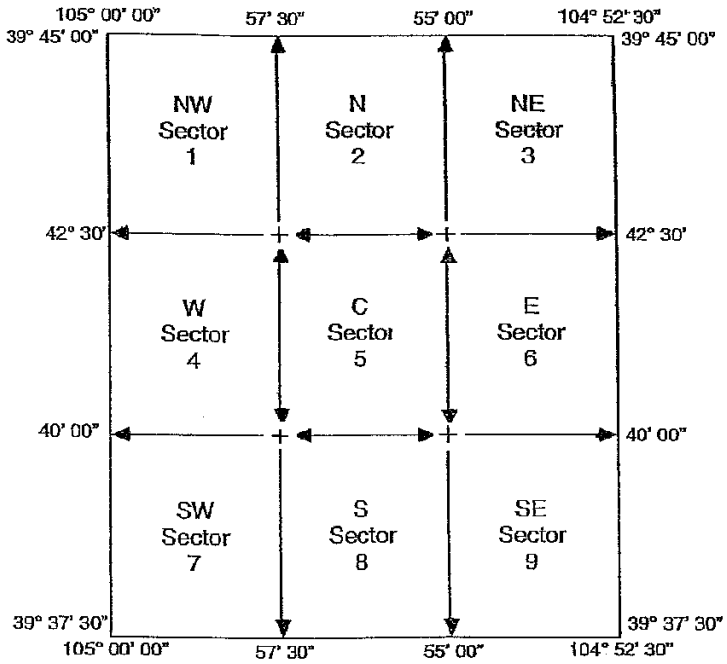


<u>WRITING BEARINGS</u> – Turn East or West from the N-S line to a maximum of 90°. The bearing value always has an N or S prefix and an E or W suffix. Use two digits for degrees, e.g., N 06° W. Use two digits for non-zero minutes and seconds. Must have minutes if you have seconds, even if 00’.



SECTORS

The four graticule intersections (+) or tick marks on the topographic map divide the map into nine sectors as shown below. You can call a sector by the number or the direction. Best is to use both. E.g., Southwest Sector 7. **NOTE**: **Sectors** are **NOT** the same as PLSS **sections**.



NUMBERS TO KNOW:

One mile = 5280 feet or 63,360 inches
One kilometer = 3280.84 feet or 1000 meters
One nautical mile (NM) = 6076.1157 feet or 1852.0 m or ≈ one minute of latitude

Miles to kilometers = x 1.609344
Kilometers to miles = x 0.621371
Feet to meters = x 0.3048
Meters to feet = x 3.28084
Inches to millimeters = x 25.40
Millimeters to inches = x 0.03937

Quick scales at **1:24000**:
1000' = 12.7 mm or 0.5 in
2000' = 25.4 mm or 1 in
1000 m = 41.67 mm
1 mi = 67.06 mm
2.5' or 150" of latitude ≈ 192.7 mm
These are math computations for a topographic map. Drawing and reproduction errors on an actual USGS map will cause slightly different values. Do NOT use with highway maps.

List Maps Used On Test:
Name Date (if you can find it)

_____

_____

_____

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For questions, comments and suggestions, please contact Dan Haggarty – sciolydanh@yahoo.com