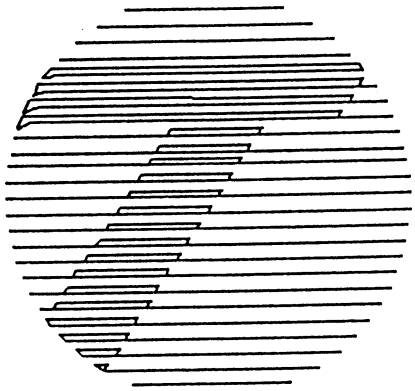
Technicians Guide to Engineering Fundamentals

NYS Department of Transportation



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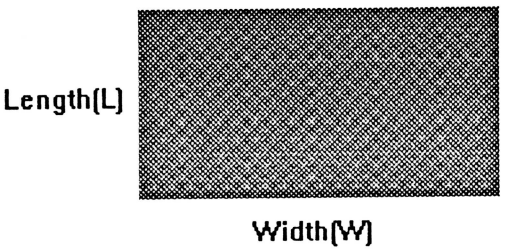
Main Office
Soil Mechanics Bureau

Areas Cont.

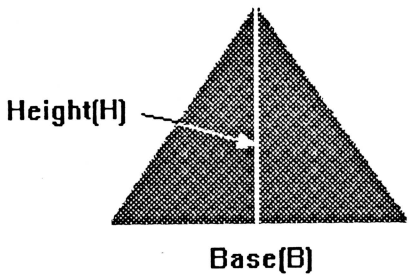
Rectangle:

Area = L x W
Perimeter = 2 L + 2 W



Triangle:

Area = 1/2 B x H



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Polygons

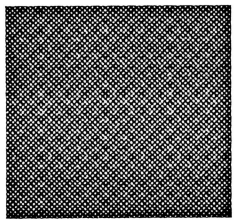
Sum of interior angles of a Polygon = 180^{o} x (N-2)
Where: N = number of sides

Number of Sides	Name
3	triangle
4	rectangle
5	pentagon
6	hexagon
7	heptagon
8	octagon
9	nonagon
10	decagon

Areas

Square:

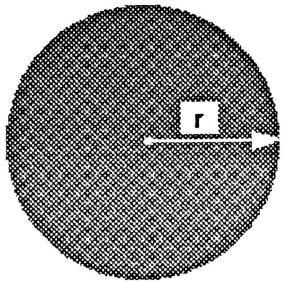
Area = L^2
Perimeter = 4 L



Areas Cont.

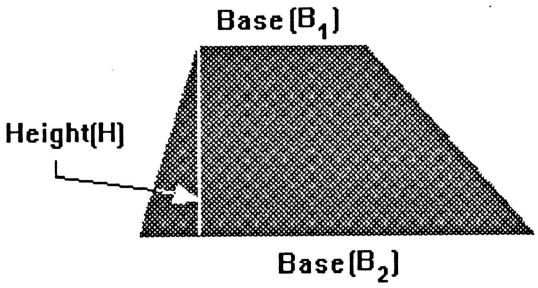
Circle:

Area = πr^2
Circumference = $2 \pi r$



Trapezoid:

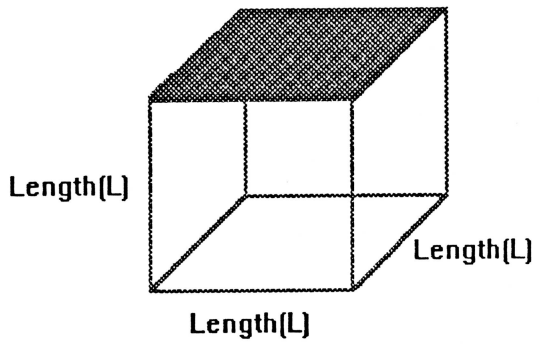
Area = 1/2 H x (B_1 + B_2)



Volumes

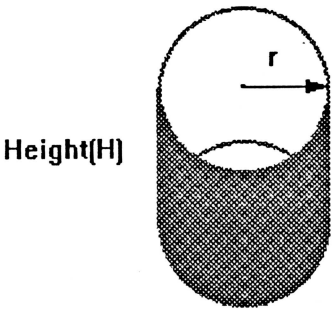
Cube:

Volume = L^3



Cylinder:

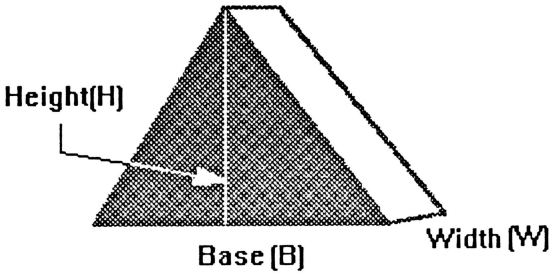
Volume = $\pi r^2 x H$



Volumes Cont.

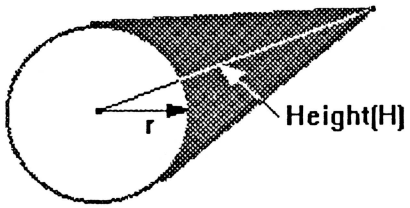
Prism:

Volume = 1/2(B x H) x W



Cone:

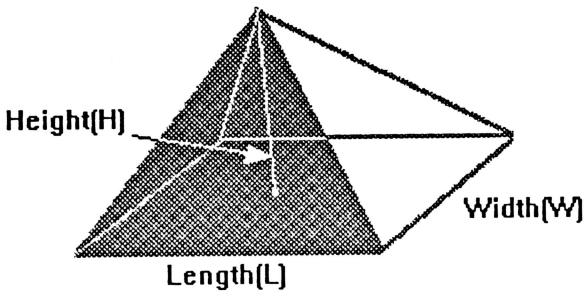
Volume = $1/3\ \pi\ r^2 \times H$



Volumes Cont.

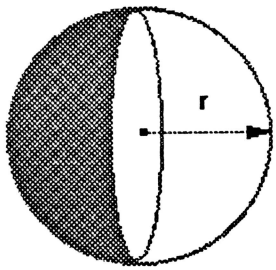
Pyramid:

Volume = 1/3 L x W x H



Sphere:

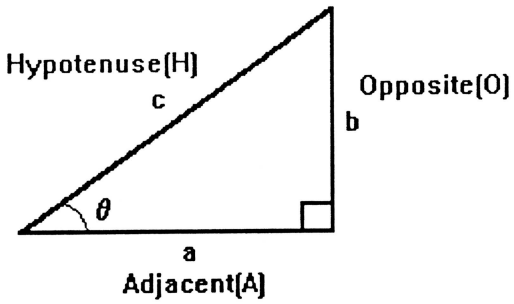
Volume = $4/3\ \pi\ r^3$
Surface Area = $4\ \pi\ r^2$



Trigonometry of Right Angles

$\sin\theta = \frac{O}{H}$ $\cos\theta = \frac{A}{H}$ $\tan\theta = \frac{O}{A}$

$\csc\theta = \frac{H}{O}$ $\sec\theta = \frac{H}{A}$ $\cot\theta = \frac{A}{O}$



Pythagorean Theorem: $a^2 + b^2 = c^2$

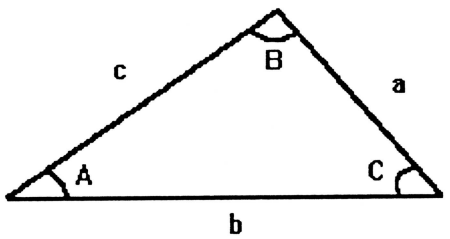
Trigonometry of Oblique Triangles

Law of Cosines:

$a^2 = b^2 + c^2 - 2\,b\,c\,(\text{Cos } A)$
$b^2 = a^2 + c^2 - 2\,a\,c\,(\text{Cos } B)$
$c^2 = a^2 + b^2 - 2\,a\,b\,(\text{Cos } C)$

Law of Sines:

$$\frac{\text{Sin}A}{a} = \frac{\text{Sin}B}{b} = \frac{\text{Sin}C}{c}$$



Conversions

1 mile = 5280 ft.
1 cubic yard (yd^3) = 27 cubic feet (ft^3)
1 ft^3 = 7.48 U.S. gallons
1 cubic foot of water weighs 62.4 lbs.
Board ft. = Length (**ft.**) x width (**ft.**) x thickness (**in.**)

ex. 1 Board ft. = 1 ft.x 1 ft. x 1 in.
2 Board ft. = 2 ft. x 1 ft. x 1 in.
or 1 ft. x 1 ft. x 2 in.
or 4 ft. x 0.5 ft. x 1 in. , etc....

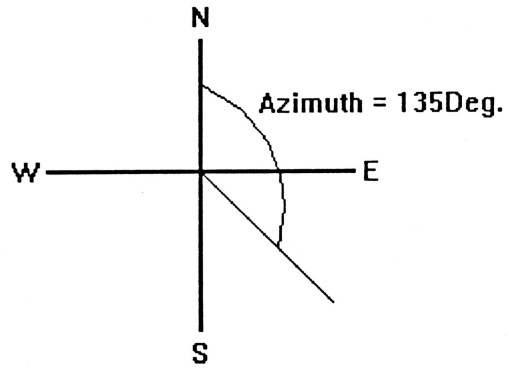
Density (lb/ft^3)= mass (lb) / volume (ft^3)
Temperature: $^{\circ}F = 9/5\,^{\circ}C + 32$

Surveying

Azimuth:

Angle(0^{o} to 360^{o}) formed by a line measured in a clockwise direction from the north branch of the meridian(N/S line). This is known as an *azimuth from the north.* (*Azimuths from the south* are also sometimes used.)

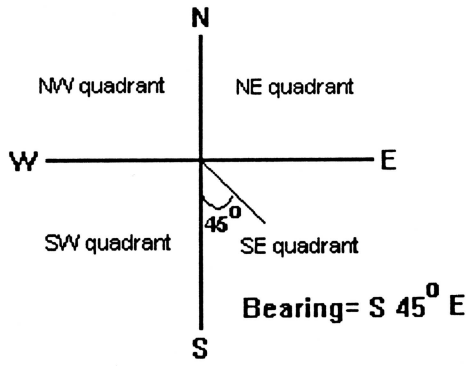
ex.



Bearing:

The bearing of a line is referenced to the quadrant in which the line falls and the angle that the line makes with the meridian(N/S line) in that quadrant. It is necessary to specify the two cardinal directions that define the quadrant in which the line is found(i.e. NE, SE, SW, NW). The north and south directions are always specified first.

ex.



Surveying Cont.

Latitude:

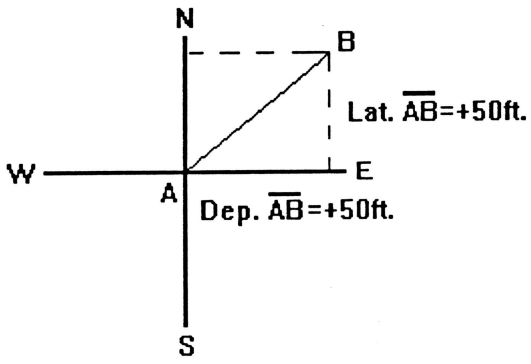
Distance that the line extends in the North/ South direction.

Departure:

Distance that the line extends in the East/ West direction.

North Lats. (+)
South Lats.(-)
East Deps. (+)
West Deps. (-)

In a closed traverse: Sum of Depatures = 0
Sum of Latitudes = 0



Surveying Cont.

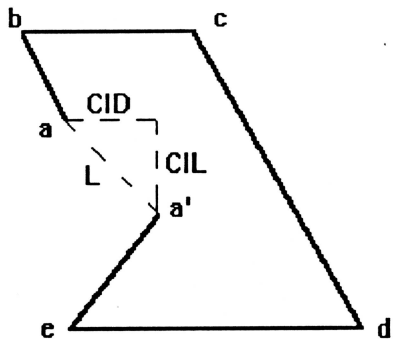
Traverse closure:

The line that will exactly close a traverse. The length of a traverse closure is:

$$L = \sqrt{(CID)^2 + (CIL)^2}$$

where:

L =	Length of Traverse Closure
CID =	Closure in Departure
CIL =	Closure in Latitude



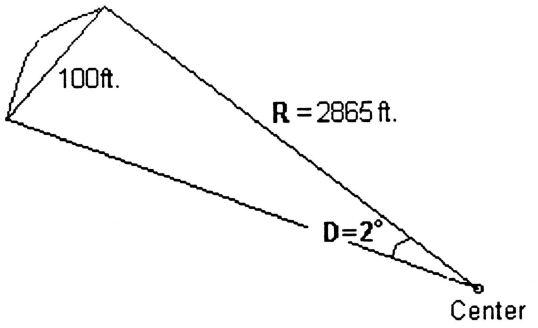
Surveying Cont.

Degree of Curve:

The angle subtended by a chord of 100 ft. Knowing the radius of a curve, we can find the degree of curve.

$$\text{Degree of Curve (D)} = \frac{5730}{R}$$

For a two degree curve, the radius is equal to 2865ft.



Surveying Cont.

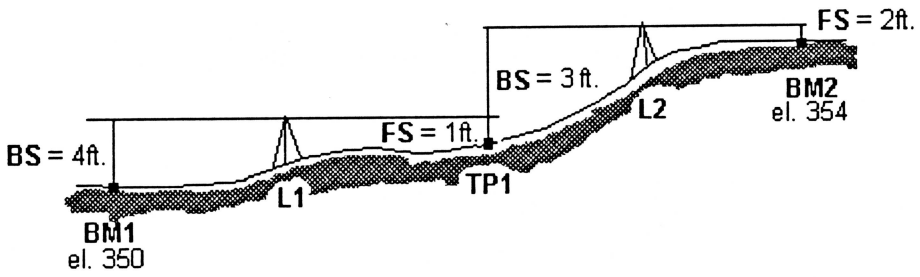
Differential Leveling:

The difference in elevation between two bench marks can be determined by subtracting the Front Sight(FS) elevation from the Back Sight(BS) elevation.

The elevation at BM1 is 350 feet. The BS from L1 is 4ft. above BM1 and the FS from L1 is 1ft. above TP1. The backsight from L2 is 3ft. above TP1 and the FS from L2 is 2ft. above BM2.

The elevation of BM2 = (el.BM1)+ (sum of BS) - (Sum of FS)

= (350ft.) + (4ft. + 3ft.) - (1ft. + 2ft.) = **354** ft.

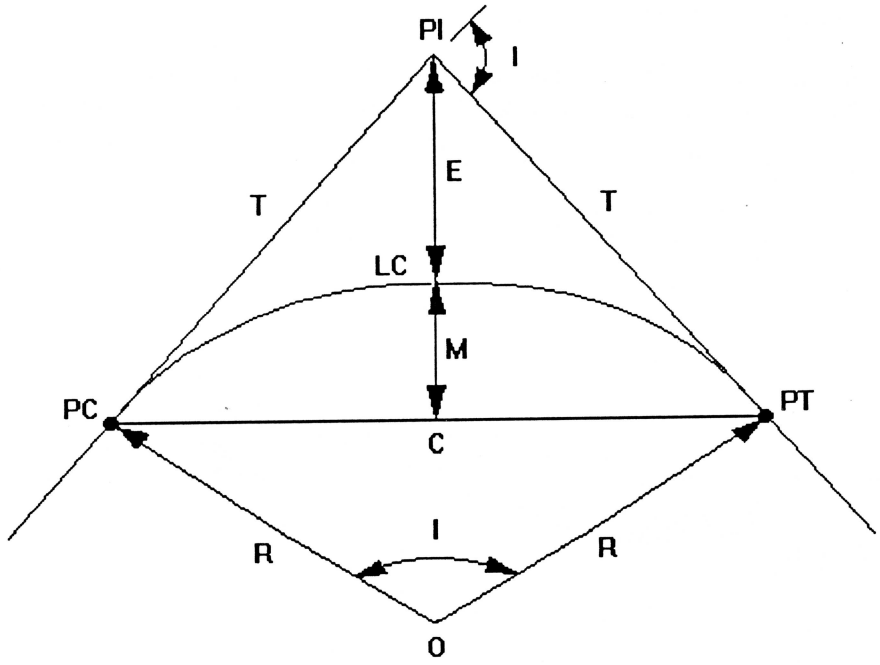


Misc. :

Expansion factor for steel tape: 0.0000065 ft./ ft. of tape/ degree over 65°F
Survey rod is read to the nearest 100th of a foot.
The Scale 1 : 31, 800 is termed as 1 inch equals 31, 800 inches.
A 1% Grade rises/falls 1 foot every 100 feet.

Surveying Cont.

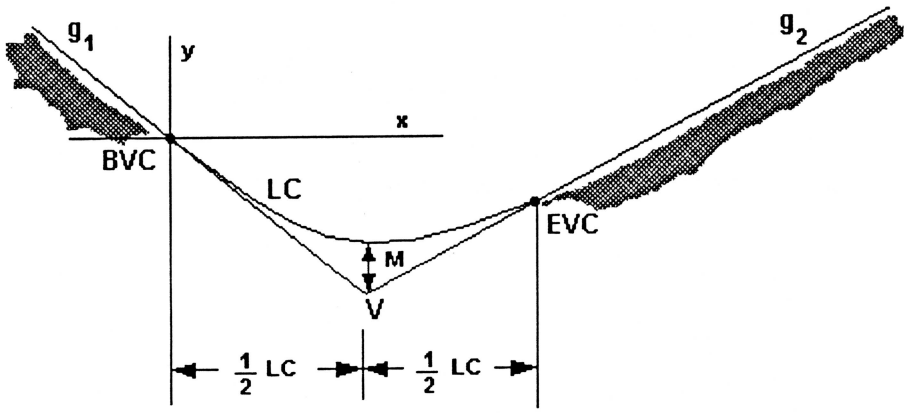
Horizontal Curves:



R	radius of the curve
PI	point of intersection
I	interior angle
PC	point of curvature - the place where the first tangent ends and the curve begins
PT	point of tangency - the place where the curve ends and the second tangent begins
LC	length of the arc - the length of the curve from PC to PT
T	tangent distance from PI to PC or from PI to PT
C	the long chord - the straight distance from PC to PT
E	the external distance - the distance from PI to the midpoint of the curve
M	the middle ordinate - the distance from the curve midpoint to the midpoint of the long chord
O	center of the curve

Surveying Cont.

Vertical Curves:



LC	the horizontal length of the curve, in stations
g_1	the grade from which stationing starts, in percent
g_2	the grade towards which the stationing heads, in percent
V	the vertex - the intersection of the two tangents, also called PVI
BVC	beginning of the vertical curve, also called PVC
EVC	end of vertical curve, also called PVT
M	middle ordinate

The *Middle ordinate* is:

$$M = \frac{[g_1 - g_2][LC]}{8}$$

The maximum or minimum elevation will occur at the *turning point.* The turning point(X) is located at:

$$X = \frac{g_1[LC]}{[g_1 - g_2]}$$