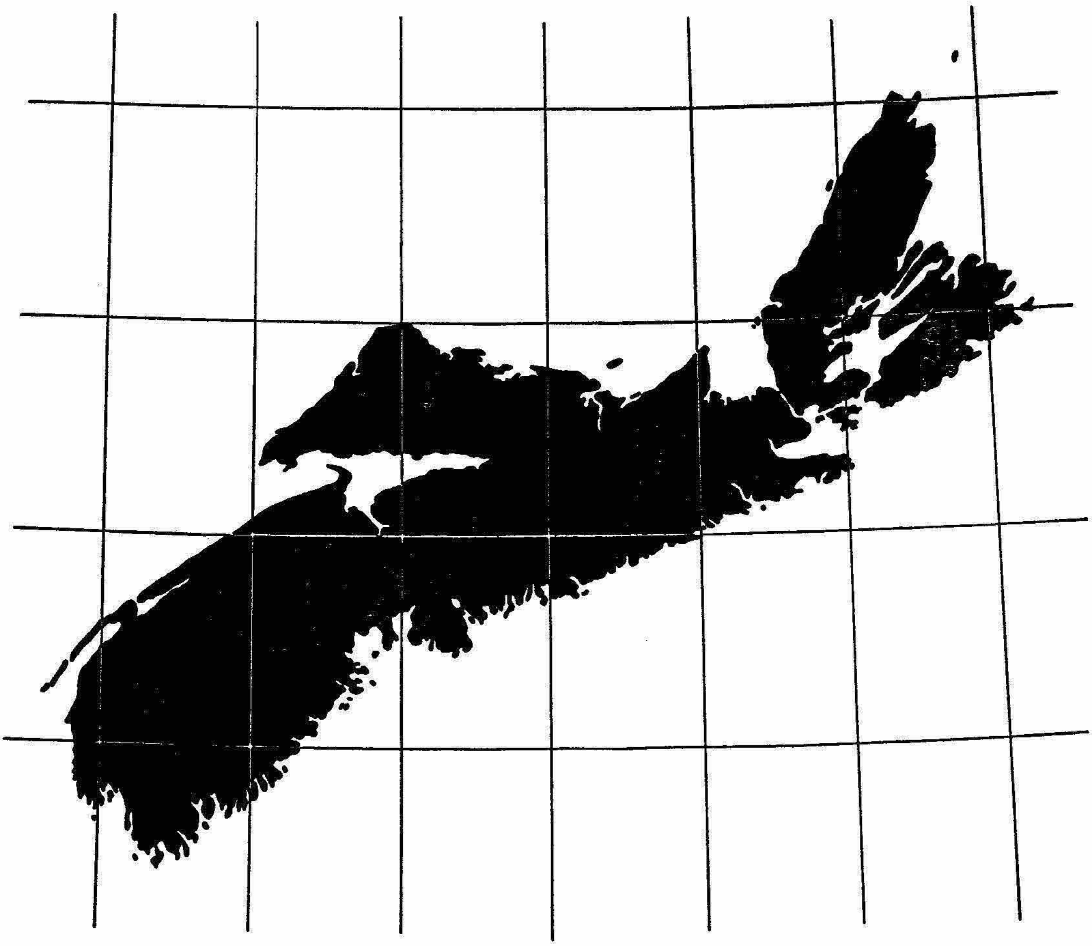
The NOVA SCOTIAN SURVEYOR



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ADMIRAL PULLEN R. C. N. RETIRED

SPEECH

AT 15th ANNUAL MEETING OF THE ASSOCIATION OF PROVINCIAL LAND SURVEYORS OF NOVA SCOTIA

I welcome this opportunity to come here and explain the Atlantic Provinces role in the 1987 World's Fair in Montreal.

Every day we read and hear more about Expo '67 and what it will mean for Canada during her Centennial less than two years away.

We hear of the large amount of money, time and planning that are being put into the Fair to make it a success.

And a success it must be - for in 1967 the rest of the world will be looking at Canada to see if she has finally and rightfully taken her place among the nations of the world.

Canada's reputation - the reputation of every Canadian - is at stake in 1967.

Expo '67 is not a Quebec show or an Ontario show; it's an all-Canadian show and it is our duty as Canadians - whether we're from Nova Scotia, Newfoundland or wherever - to make sure that Expo is a success.

You may ask:

"How can we in the Atlantic Provinces properly and fittingly participate in Expo when such provinces as Ontario and Quebec are spending millions on their pavilions?"

Our pavilion may not be the largest or the most expensive - but I can assure you this, that dollar for dollar it will be one of the most striking, most interesting and one of the most unique structures to grace Ile Notre-Dame.

And for the next few minutes I will explain what we are attempting to present at Expo.

It is not my job here today to go into the background of Expo '67, how it came about and what you may expect to see there when it opens in late April, 1967.

That role belongs to my good friend General E. C. Plow who is Expo's Regional Director of the Atlantic Provinces.

My job is to tell our people what the Pavilion will look like, what it will contain, what we hope to achieve at Montreal, and how you as individuals can contribute to it's success.

First I would like to explain why the four Provinces decided earlier this year to undertake a joint venture instead of having individual representations.

One of the reasons against individual representations naturally was money - it would simply have been too costly an undertaking - another reason is duplication; but perhaps the most important reason for joint participation was the strong showing it would ensure.

Atlantic Canada is gaining identity as an area - especially for its rapid economic development.

Our status in Canadian Councils is enhanced when we speak together; we have an opportunity at Expo to appear as a vigorous area to be watched, and we are more likely to make an impression together than if we tell our stories separately.

The underling theme of the Pavilion is the Atlantic, The Sea, the one thing we all have in common. The Atlantic influence shapes our four provinces and no others.

Pavilion Architecture:

To attract a good percentage of the potential 30,000,000 visitors to Expo our designing consultants and architects designed a Pavilion that not only would attract people but would properly tell our story.

We wanted a Pavilion that would stress our strong historical contribution to the nation, our present economic advancement, and the prosperous future that lies ahead.

There will be approximately 100 Pavilions at Expo, plus an amusement area, a stadium, special attractions, etc. To date 68 countries have signified their intention of participating; this figure is expected to reach 80.

With this in mind we needed a Pavilion that not only would attract people, but also make them want to know more about us.

Our Pavilion will accomplish this and more.

It is ideally situated on the water, between the huge Canadian complex and the Spanish Pavilion.

The Pavilion has been described by it's designers as "a spontaneous building, not copied or derived from any other, and is a unique architectural statement which suits the surroundings and has the spirit of the Atlantic area in it."

One of its most striking features will be a large cantilever roof. The unequal cantilever trusses of 75 and 45 feet provide a roofed area of 120 by 120 feet.

A mono-rail, capable of carrying 6000 visitors an hour, passes by the Pavilion, providing a healthy supply of potential clients!

Schooner:

One of our biggest drawing cards will be a 40 foot schooner under construction.

A Lunenburg County crew, under the direction of David Stevens of Second Penin-will be a great asset to the Pavilion.

The experience gained at the New York fair and others has shown that people actually doing things attract the most viewers. This we hope will be the case with the schooner.

It will also provide an excellent opportunity to display the type of craftsmanship that has made Nova Scotia and the region world famous down through the years.

Restaurant:

Also included in our Pavilion plans is a top-flight Seafood Restaurant. This we feel will be a great asset to the Pavilion.

We plan to serve high-quality seafood - one of our main exports - at moderate prices in pleasant surroundings.

The location of the restaurant will provide an excellent view of Montreal. It will be an experience that the whole family will enjoy.

I am happy to report that Tenders were called October 15th for construction of the Pavilion. Work is expected to get underway in November.

Exhibits:

Among the Exhibits will be cultural displays which will present the ethnic origins, environmental limits and opportunities and historical events which have made the Atlantic Provinces what they are today. Migrations, natives, folklore, pioneer inventions, local myths, dramatic events and regional heroes will all have their place.

Marine exhibits will display the close relationship between the four Provinces and the Atlantic. This will be most evident in the marine objects located carefully in the complex.

In summing up, I would say that the Pavilion will attract a good percentage of the 30,000,000 people visiting Expo and that it can accomplish the following:-

It can interpret the Atlantic Provinces to Canada and the world and leave an image of a beautiful place which has both a past and future.

It can further encourage the consciousness of the Canadian Atlantic Provinces themselves as an area of great diversity, often unified by common interests and opportunities.

It can engender a great sense of pride in the whole area.

It will, without doubt, establish many contacts, social, cultural, industrial and institutional, which can have far-reaching effects on the economic and cultural future of the Atlantic Provinces.

The general objective is to present an attractive Pavilion with an unmistakable air of Atlantic Canada, dealing with visitors with a relaxed, human touch, while effectively interpreting the idea of a varied, beautiful area with much to offer industrialists, to workers, to vacationists, to retired people and to anyone who just wants a good place in which to live.

My personal feeling is that it will do all this, and with your efforts and others like you, even more.

A SURVEYOR'S VIEW OF A COORDINATE SYSTEM

BY JIM DOIG P. L. S.

NOVA SCOTIA LAND SURVEY INSTITUTE

The object of this account is to explain how the practicing surveyor can use a coordinate system - especially to say what he is given to work with and to what extent he must employ mathematics.

Any coordinate system brought into use over a large area (say a province) is designed by the geodesist who must consider among other things:

(a) The size and shape of the area and,

(b) The relative precision of the work to be done within the system.

The geodesist is faced with the problem of representing the curved surface of the earth by a plane. Distortion is inevitable. However, the land surveyor does not ordinarily work to a precision better than one part in ten thousand parts. Hence if the distortion in the system is not greater than this the user cannot detect it. The result will be that FOR THE LAND SURVEYOR A KNOWLEDGE OF LATITUDES AND DEPARTURES IS ALL THAT IS NECESSARY TO USE SUCH A COORDINATE SYSTEM.

Once the geodesist knows the limiting factor he designs the system and culminates the work by calculating the rectangular coordinates of those existing control points in the province for which positions have been determined with an accuracy equal to or greater than that desired. These coordinate values are given to the provincial government and it makes them available to anyone who wishes them.

It usually happens that the existing control is not sufficiently dense to be of immediate use to the land surveyor and the provincial government must establish more monumented control points.

Assuming that this had been done in an area in which a land surveyor wishes to work, what does the surveyor encounter on the ground? He finds two intervisible monuments for which a variety of positional data is available. Let it be assumed that there is available only the minimum information, namely the rectangular coordinates of the individual stations. For example:

Sta 7	Coord East	625.0 ft.
	Coord North	327.4 ft.
Sta 8	Coord East	1735.3 ft.
	Coord North	492.7 ft.

From this it is evident that both monuments are located east and north of a common beginning point. The location of the beginning point is of no immediate interest. THE SURVEYOR IS INTERESTED IN THE RELATIONS BETWEEN THESE MONUMENTS, for the line between the monuments will serve him as a baseline. The relations wanted are the length of the line between the monuments and its direction with respect to other similar lines in the system. These are obtained as follows:

E. 8 = 1735.3	N. 8 = 492.7
E. 7 = 625.0	N. 7 = 327.4
departure = +1110.3 ft.	latitude = +165.3 ft.

$$\text{distance 7 to 8} = \sqrt{dep^2 + lat^2} = 1122.5 \text{ ft.}$$

$$\tan(\text{bearing 7 to 8}) = \frac{dep}{lat} = \frac{+1110.3}{+165.3} = 6.71688$$

bearing 7 to 8 = N. 81° - 32' E.

The surveyor thus is in possession of a base line with the following characteristics:

a) both ends are monumented

b) length is 1122.5 ft.

c) bearing of line is N. 81° - 32' E.

It is obvious that this calculation can be done at the provincial government level and the results given to the user in the form of a card giving bearing and distance from each monument in the system to all other visible monuments in the system.

From here on the surveyor can use the base line to do one of two things:

a) EITHER he can record points or objects on the ground in terms of his base line by determining their rectangular coordinates

b) OR he can find a point or an object on the ground if he has been given the rectangular coordinates of it.

Suppose he wishes to do the first. Setting up at 7 he sights on 8, turns an angle to the right of 15° - 10' and measures out 321.5 ft. to the corner of a building (A). ~~THEN~~ then:

line 7 to A has: distance 321.5 ft.

bearing S. 83° - 18' E.

departure of A from 7 = +319.3

latitude of A from 7 = - 37.5

Hence $E_A = E_7$ + departure = 625.0 + 319.3 = 944.3 ft.

$N_A = N_7$ + latitude = 327.4 - 37.5 = 289.9 ft.

As an illustration of the second situation suppose the building is later demolished and it is desired to establish the location of the corner armed only with its coordinates, that is the surveyor must solve the problem "where is point E. 944.3, N. 289.9?"

He has only to go back to 7 and run an open traverse to a point which in relation to 7 has a departure of +319.3 and latitude of -37.5. He may equally well choose to work from 8 in which case he runs a traverse to a point which in relation to 8 has a departure of -791.0 and latitude of -202.8.

Obviously, this whole argument can apply to any base line whatsoever and in itself is a most elementary proposition in surveying. The benefit of the coordinate system established province-wide is that anything located with respect to the given base line is located with respect to every other possible baseline in the system. Should the two monuments first employed disappear in course of time, every other monument in the system stands as a witness to this baseline and to any measurements referred to it. In practice monuments do disappear or become displaced. A system of inspection and replacement is necessary in order to maintain the desired density of monumentation in any particular area.

Two of the arguments advanced against the establishment of a coordinate system invariably are the mathematical complexity of such a system and the cost of monumentation. The only difficult mathematics involve the geodesist, not the surveyor. The monumentation can be carried out a section at a time where the need is greatest and monumentation is a capital expenditure which has returned dividends wherever used. A case in point is New Brunswick which began such a system in 1959 and is making extensive use of it to their benefit.

Some of the immediate benefits to the users of such a system in Nova Scotia would be:

(a) positional control by municipal survey departments in high density building areas

(b) systematic preservation of the mathematical description of lot boundaries referred to the system.

(c) municipal tax and assessment problems over "lost" and "shifting" lots could be solved permanently.

(d) detailed planning for highways and for city fringe areas could be carried out in sections which will later fit together with certainty.

(e) mineral land boundaries could be located with greater certainty and less computation than is now possible.

(f) existing and future surveys can be integrated and duplication avoided.

A word of warning is necessary lest the user become overconfident. One can only get out of the system what one puts in. If points are referenced to the coordinate monuments with a relative precision of 1 in 1000, it is useless to come back later and expect to relocate these points with a relative precision of 1 in 10,000. It's the old story: given two decimal places in the answer you can always round off to one place, but with one place only, you can't tell what the second might be.

A THOUGHT

YESTERDAY, TODAY, TOMORROW

Yesterday

What did yesterday mean to you? Now that yesterdays tomorrow is today!

Was it just another day or was it the day you planned it to be yesterday. Did you add it to your knowledge or did you put it off until tomorrow, which is now today. How many tomorrows will there be for you that will let you look back at yesterday and at those things you put off until tomorrow.

Today

Today is yesterdays tomorrow, the day you looked forward to yesterday. Will today be tomorrows yesterday or just another tomorrow?

Yesterday a method was found to compute time and distances.

Today some one will find a new method to compute Time in Space.

Tomorrow some one will find another way to travel in space.

Yesterday it was said that man could not travel through the air.

Today air travelling has reached, and exceeds the speed of sound.

Tomorrow a method will be found to travel in time and space. Imagine if you can the computations involved, the prearranged and programmed data that will be required, the observations and the infinitesimal accuracy needed to-day to travel to-morrow.

Today you have the time to do that job accurately; if you wait until tomorrow will it be too late? You owe it to yourself today and to those who will employ you tomorrow to be accurate and to give value for your time. The mistakes you made yesterday are done and cannot be undone. You cannot turn back time today, nor can you catch up with time tomorrow, but time can catch up with you.

Yesterday is the span of time, man's yesterday began hundreds of thousands of years ago.

Today is the shortest part in the span of mans time.

Tomorrow extends to infinity which is far beyond mans time on this planet.

Yesterday you had a choice. Today you have a chance. Tomorrow you will see someone do that which you had a choice and chance to do.

Will you be ready for tomorrow, when your chance comes today? or did you miss it yesterday?

REDDY vs. STROPLE NSR 44 p. 332 (1909) GUYSBOROUGH

The title to the land in question depended upon the reading of the description in the defendant's deed, the material portion of which was as follows: "Thence running in an eastwardly direction along the said highway until it comes to a crossway (a kind of culvert or bridge) in the public highway, and running in a southerly direction until it comes to the waters of Broad Cove, etc."

There were two crossways on the highway. The dispute was over which was meant.

HELD: (1) There was no authority for rejecting the first crossway in favor of the second

(2) The words "running in a southerly direction, etc" did not demand a straight course but only a southerly direction

(3) Defendant was not bound by an alleged conventional line agreed to between the parties "if found to be correct," in the absence of evidence to show that it was found to be correct, and Where it appeared that, at the time the agreement was made

(4) In interpreting the agreement (about the conventional line) both the agreement and the plan referred to in it must be considered

(5) Effect must be given to the instrument, where possible, against the grantor.

DAVISON vs. BENJAMIN 9 NSLR Vol. 111 p. 474 (1874) KENTVILLE

"Several crown grants from which plaintiff deduced his title purported to convey a specified number of acres, described as contained within lines commencing at a fixed point, and running specified distances to other points indicated by marked trees and other monuments, which appeared upon plans annexed to and referred to in the body of the grants.

HELD: that the monuments, being ascertained, must control the quantities purported to be granted, and the distances mentioned in the grants, notwithstanding the fact that the number of acres included in that case would be enormously in excess of the number which the grants purported to give. The least objectionable of all difficulties is to make quantities whether too great or too small, yield to actual monuments on the ground."

Per Sir W. Young, C. J.: "The grants might have been attacked by the crown for excess but, in the absence of such proceedings, the land included could not be re-granted to a stranger. Under the usage of the court, parole evidence is admissible to show the actual position and surveys of lands included in grants of wilderness and woodlands."

Discrepancies in the areas were:

Lot	Deed	Actual
A	400 ac.	672 ac.
B	100 ac.	772 ac.
C	100 ac.	760 ac.
D	100 ac.	400 ac.

CAIN vs. UHLMAN 20 NSLR p. 148 (1887)

" ......The witness whose evidence was rejected testified that he was a practical mill builder, that he had erected water power mills, and that in doing such work he had to take levels, to get a height, but that he did not know how to use a theodolite.

HELD: that the evidence should have been received."

Per MacDonald, C. J. at p. 151: "Now it is quite probable that a theodolite is the best, most correct and convenient instrument for taking levels, but its absence does not by any means make it impossible for a practical man like the Witness, Esty, to arrive at correct conclusions as to the respective levels of the different points of a stream by other means with which he was familiar and which he had been accustomed to use with approximate correctness in the exercise of his trade and business. It would be for the jury, I conceive, to estimate the value to be attached to his testimony, and the efficiency of the apparatus used by him."

FREEMAN TUPPER, P. L. S.

It is with deep regret that we have to announce the passing of Freeman Tupper, P. L. S., Milton, on May 4, 1966, at New Minas, Kings County.

Freem - to his Many friends - was an early member of the Association of Provincial Land Surveyors and its President for the year 1956-57, and always active in the promotion of the well being of his chosen profession, land surveying.

Born at Milton in 1889, the son of Henry and Teressa (MacDonald) Tupper, a descendant of Nathan Tupper, one of the original Grantees of the Township of Liverpool. He was born and resided in the old Tupper homestead, Milton, and obtained his early education in this community. He later attended Dalhousie and in 1912 the Technical College, Halifax, where he obtained his diploma as a Provincial Land Surveyor.

After obtaining his diploma he joined the old McLeod Pulp and Paper Company and remained with them until 1928 when he went with the Mersey Paper Company in their woodlands Department and later in their woodlands operations in Cape Breton and St. Margaret's Bay. Shortly after the outbreak of war he joined the fuel control board and remained with it until its dissolution. Following this he engaged in the purchase of pulpwood for the export market but shortly thereafter joined the Department of Highways as their Lands and Rights Engineer. He retired from this department in 1964 and immediately joined the Department of Lands and Forests in the same capacity or as Claims Adjuster on the Kejimkujik National Park.

The last of the name in Milton, where the Tuppers played a leading role for over two hundred years. Endowed with a very pleasant personality he will be long remembered by his host of friends in the community and throughout the Province.

The exceptionally large funeral in the Baptist Church, Milton, May 7th, was emblematic of the high esteem in which he was held both by the community and his many friends throughout the Province.

GONE BUT NOT FORGOTTEN.

Introduction to Spherical Trigonometry Part 2

Reference Texts:

Plane and Solid Geometry - Wentworth & Smith $4.80

Plane and Spherical Trigonometry - Wentworth & Smith $4.12

Publishers Ginn & Coy Toronto

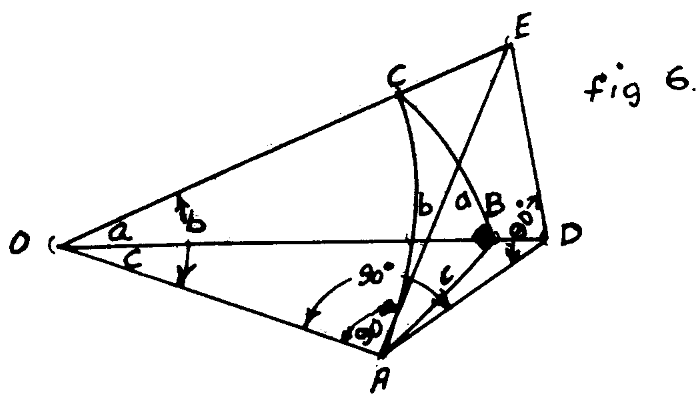
James A. H. Church P. L. S. Nova Scotia

Right Spherical Triangle

Given The right spherical triangle ABC in which the angle B = 90°

and angles A and C are less than 90°, O being the centre of the sphere

Fig. 6



Construction At point A draw a plane tangent to the sphere

Produce OC and OB to intersect the tangent plane at E and D respectively

Proof $\frac{OD}{OE} = \cos a$ and $\frac{OA}{OD} = \cos c$

$$\frac{OD}{OE} \cdot \frac{OA}{OD} = \cos a \cdot \cos c$$

OD cancells out and $\cos a \cdot \cos c = \frac{OA}{OE}$

$$\therefore \cos b = \cos a \cdot \cos c \qquad (1)$$

The above is merely plane trigonometry applied to a triangular pyramid

In Triangle ADE plane AED is tangent to the sphere const.

therefore the lines AD and AE are tangent to the sphere and the angle EAD is the measure of the angle A in the spherical triangle ABC

Solid Geometry p. 391

In triangles ADE, AED, and OAE

$\sin A = \frac{ED}{EA}$, $\sin a = \frac{ED}{EO}$, $\sin b = \frac{EA}{EO}$ and $\frac{1}{\sin b} = \frac{EO}{EA}$

$\therefore \frac{\sin a}{\sin b} = \frac{ED}{EO} \cdot \frac{EO}{EA}$ and EO will cancel out

$\therefore \frac{\sin a}{\sin b} = \sin A$

i. e., $\sin a = \sin b \cdot \sin A$ (2)

By passing a tangent plane through point C and similar reasoning, one may obtain:–

$\sin c = \sin b \cdot \sin C$ (3)

$\tan A = \frac{DE}{DA}$, $\sin c = \frac{DA}{DO}$, and $\tan a = \frac{DE}{DO}$

$\therefore \tan A \cdot \sin c = \frac{DE}{DA} \cdot \frac{DA}{DO}$ and DA cancels out

$= \frac{DE}{DO}$

$\therefore \tan a = \tan A \cdot \sin c$ (4)

Similarly one may obtain $\tan c = \tan C \sin a$ (5)

These 5 equations are important because from them may be deduced two Basic Rules for the solution of the Right Spherical Triangle. It must be borne in mind that the sum of the sides of a spherical triangle can not exceed 360° and that the sum of any two sides is greater than the third. It follows that the greatest side of any spherical triangle must be less than 180° and the sine thereof will be always positive.

Rule 1. Deduced from equation (1) $\cos b = \cos a \cdot \cos c$

Either one side is less than a quadrant and two sides are greater than a quadrant.

(Cosines in the second quadrant are negative so two sides in the second quadrant are necessary to attain the positive sign of the side in the first quadrant.)

Or All three sides are less than a quadrant.

Rule 2. from equation (4) $\tan a = \tan A \cdot \sin c$

An oblique angle and the side opposite it are in the same quadrant. (Sine c must be positive, therefore, tan a and tan A must be in the same quadrant.)

Besides these 5 basic equations obtained from fig. 6 there are additional forms to be obtained by suitable methods. Some students memorize all these formulae, but there is no particular benefit to be gained by such procedure because any Right Spherical Triangle can be solved by Napier's Rule of Circular Parts, given any two elements.

Napier's Rule of Circular Parts

The famous mathematician, John Napier, found an ingenious method for solving the Right Spherical Triangle by two simple rules, using a diagram in which certain conventions must be followed.

Rule 1. The Sine of any Middle Part is equal to the product of the TANGENTS of the ADJACENT parts.

Rule 2. The Sine of any MIDDLE part is equal to the product of the COSINES of the OPPOSITE parts.

Conventions: For the use of the diagram and the rules, the following conventions must be observed:

1. There are three sides and two angles to be considered, the right angle being ignored - 5 parts to the triangle as indicated in fig. 7.
2. Two sides are entered in the diagram as they may be given. The third side, the hypotenuse, is always entered as the complement of the angle.
3. All angles (two in number) are entered as complement.

Fig. 7

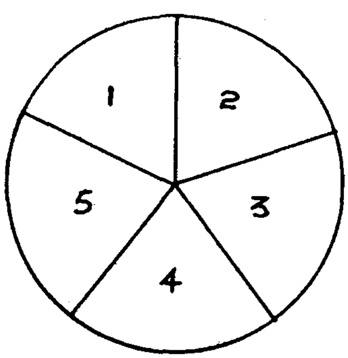


Fig. 7

All central angles are 72°

Fig. 7 shows the diagram, a circle divided into 5 equal parts numbered in this figure for the purpose of explanation to beginners. The notation used is not arbitrary as a start can be made anywhere and any part can be considered as a Middle Part.

Middle Part	Adjacent Parts	Opposite Parts
1	2 and 5	3 and 4
2	1 and 3	4 and 5
3	2 and 4	1 and 5
4	3 and 5	1 and 2
5	1 and 4	2 and 3

<u>Advice to Beginners</u>

1. Draw the triangle to be solved neatly and approximately to scale. There are two reasons for this

(a) it will save time and prevent blunders

(b) contented examiners award good marks

2. Enter the given quantities on the triangle.

3. Draw the diagram circle - central angles $\doteq 72^{o}$. A 4 inch semicircular protractor, price 10¢, will serve admirably.

4. The diagram, being a circle, may be considered either clockwise or widdershins. Make your decision and <u>STICK TO IT</u> for the sake of your examiner and yourself.

5. Whatever decision you make about direction, there will always be one side of the triangle before the right angle and that is the <u>STARTING POINT</u>.

6. On the triangle mark the right angle and also indicate it on the diagram, figs. 8 and 9.

7. Each unknown quantity <u>must be solved</u> by the use of two given quantities. The use of derived quantities is anathema - the sin of witchcraft.

8. Enter and box, or underline, all given quantities on the diagram.

9. When entering the values of functions of angles in the computation, it is IMPERATIVE that the sign of each function be entered.

<u>SOLVED EXAMPLE:</u> This is problem 9, Exercise90, p.202 in the text, selected because most of the points outlined in the foregoing are illustrated. It may serve as a model solution.

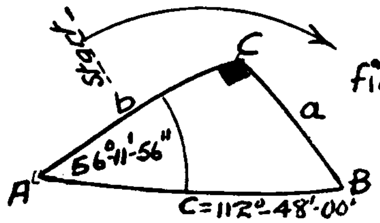


fig. 8

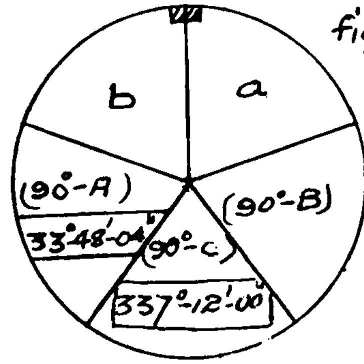


fig 9

<u>Given</u> C= 90°, c= 112° - 48', and A= 56° - 11' - 56"

To obtain complement of c which is greater than 90°

	90°-0'
augment by	<u>360° - 0'</u>
sum	450° - 0'
c	<u>112° - 48'</u>
	337° 12' = complement of c
	90° - 0' - 0"
A	<u>56° - 11' - 56"</u>
	33° - 48' 04" = complement of A

<u>To find a</u> sin a= cos (90° - c) cos (90° - A)

log sin a =	log cos 337° - 12' - 0"	$\bar{1}$. 91 958	pos
	log cos 33° - 48' - 04	<u>$\bar{1}$. 96 467</u>	pos
	sum	$\bar{1}$. 88 425	pos

<u>whence a = 50° - 00' - 00"</u>

<u>To find b</u> sin (90° - A) = tan (90° - c) tan b

$$\tan b = \frac{\sin (90° - A)}{\tan (90° - c)}$$

$\log \tan b = \log \sin 33^\circ - 48' - 04''$ $\bar{1}.74\ 532$ pos

$- \log \tan 337^\circ - 12' - 00''$ $\bar{1}.62\ 362$ neg.

difference $0.12\ 170$ neg.

whence $b = 127^\circ - 04' - 30''$

To find B $\sin(90^\circ - c) = \tan(90^\circ - A)\tan(90^\circ - B)$

$$\tan(90^\circ - B) = \frac{\sin(90^\circ - c)}{\tan(90^\circ - A)}$$

$\log \cot B = \log \sin 337^\circ - 12' - 00''$ $\bar{1}.58\ 829$ neg.

$- \log \tan 33^\circ - 48' - 04''$ $\bar{1}.82\ 573$ pos.

difference $\bar{1}.76\ 256$ neg.

whence $B = 120^\circ - 03' - 50''$

Summary

$a = 50^\circ - 00' - 00''$	Note the solution
$b = 127^\circ - 04' - 30''$	conforms with Rules
$B = 120^\circ - 03' - 50''$	1 and 2.

Polar Triangles

Reference text: Plane and Solid Geometry

Polar Triangle. If, from the vertices of a spherical triangle as poles, arcs of Great Circles are described, another spherical triangle is formed which is called the Polar Triangle of the first or Primitive Triangle. P. 394.

Polar Distance. The spherical distance from the nearer pole to a circle is called the polar distance to the circle. P. 384

Quadrant. One-fourth of a Great Circle is called a quadrant which is equal to 90° of arc. P. 384.

Properties of Polar Triangles. Fig. 10

Given two Polar Triangles each angle of the one is the supplement of the opposite side in the other.

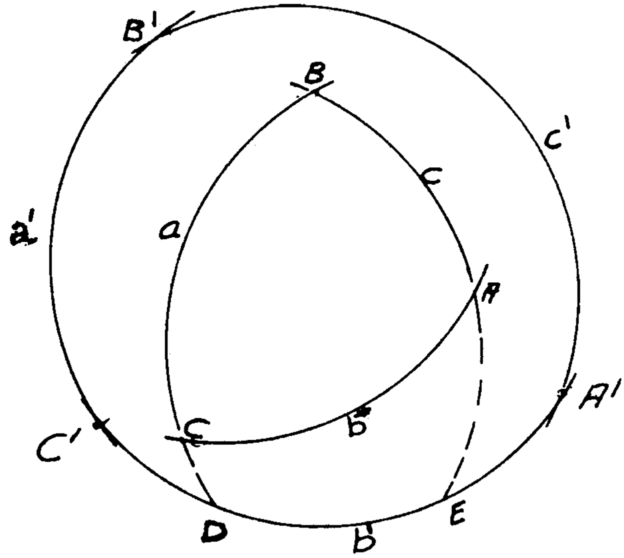


fig 10

<u>Given</u> Two Polar Triangles ABC and A'B'C'

<u>Required</u> to prove

$A + a' = 180^\circ$ $B + b' = 180^\circ$ $C + c' = 180^\circ$

$A' + a = 180$ $B' + b = 180^\circ$ $C' + c = 180^\circ$

<u>Construction</u> Produce arcs BC and BA to meet arc C'A' and D and E respectively

<u>Proof</u> C' is the pole of arc BAE $\therefore C'E = 90^\circ$

A' is the pole of arc BCD $\therefore A'D = 90^\circ$

$C'E + DA' = 180^\circ$

$DE + CD + DE + EA' = 180^\circ$

but DE is the measure of angle B and $C'A' = b'$

$\therefore B + b' = 180^\circ$

similarly $C + c' = 180^\circ$

and $A + a' = 180$

In a similar way starting with triangle A'B'C' and producing the sides of triangle ABC all other relations can be proved. Q.E.D.

<u>Note</u> The appearance of two polar triangles will vary greatly with the variations in sides of the Primitive Triangle but the proof can be made in the above manner.

Projection of the Sphere from the aspect of the Equator

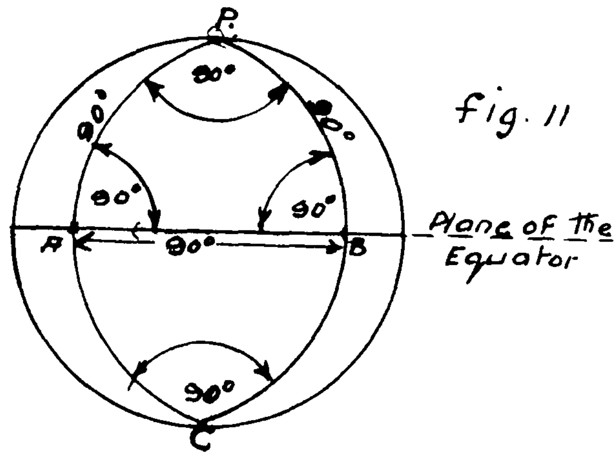


fig. 11

Projection of the sphere from the aspect of the elevated pole

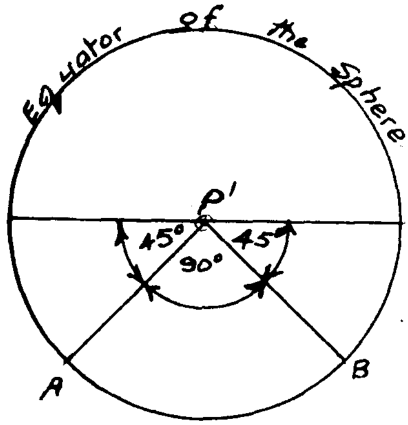


fig 12

Area of Spherical Triangles

The following general considerations must be mastered and the text studied is Plane & Solid Geometry - Wentworth & Smith.

1. Area of the Surface of a Sphere is equivalent to the area of four Great Circles i.e. $4 \pi R^2$.

   It follows that the surface of a half sphere or a Hemisphere is $2 \pi R^2$. P. 413

2. Lune That portion of a spherical surface bounded by the halves of two Great Circles is called a Lune. P. 410

   For those experiencing difficulty in visualising a Lune, an orange, peeled carefully and divided into its components without breaking the inner skins, will afford an almost perfect model of a Lune.

   Fig. 11 shows a Lune of which the angles at the poles are 90^o. If a Lune be divided into two equal parts by the equator, each part may be called a Demilune and each spherical triangle is equilateral. The sum of the angles of an equilateral Demilune is 270^o, therefore, the spherical excess of a Demilune is 90^o. The central angle being 90^o an Equilateral Demilune is ¼ of a Hemisphere, and its surface area is $\frac{2 \pi R^2}{4}$ or $\frac{1}{2} \pi R^2$

Area of an Equilateral Demilune = $\frac{1}{2} \pi R^2$

Spherical Triangle is a spherical polygon of 3 sides P. 392

Spherical Polygon the area of a spherical polygon is proportional to its spherical Excess. P. 419

Computation of Area In the triangle let T = area and E= Spherical Excess

$$\frac{\text{Area of Triangle}}{\text{Area of Equilateral Demilune}} = \frac{E}{90^o}$$

$$T = \frac{E.\ \pi.\ R^2}{2.\ 90^o}$$

$$\text{Area} = T = \frac{E.\ \pi\ R^2}{180^o}$$

James WH Glunel(?), P.L.S
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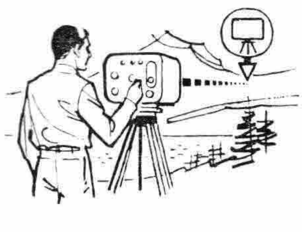

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