GEE 4812:
Principles of Geomatics

Traverse Computations

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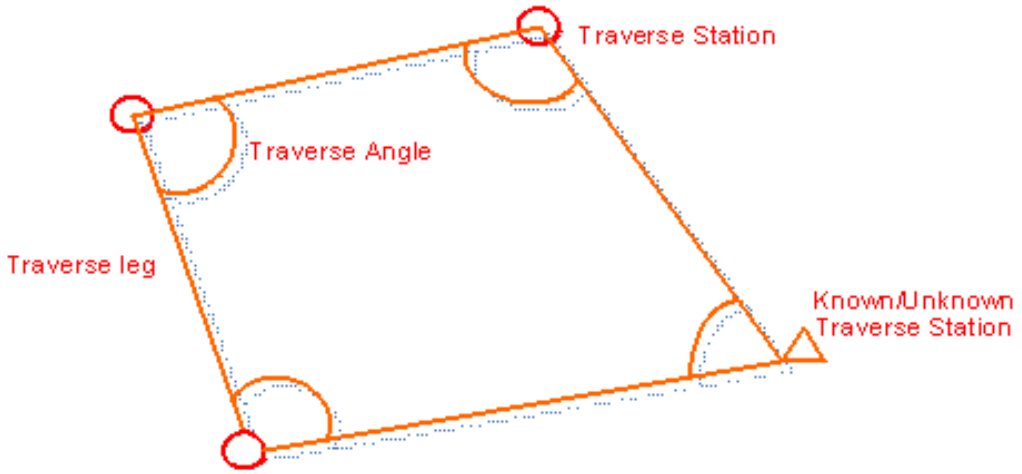
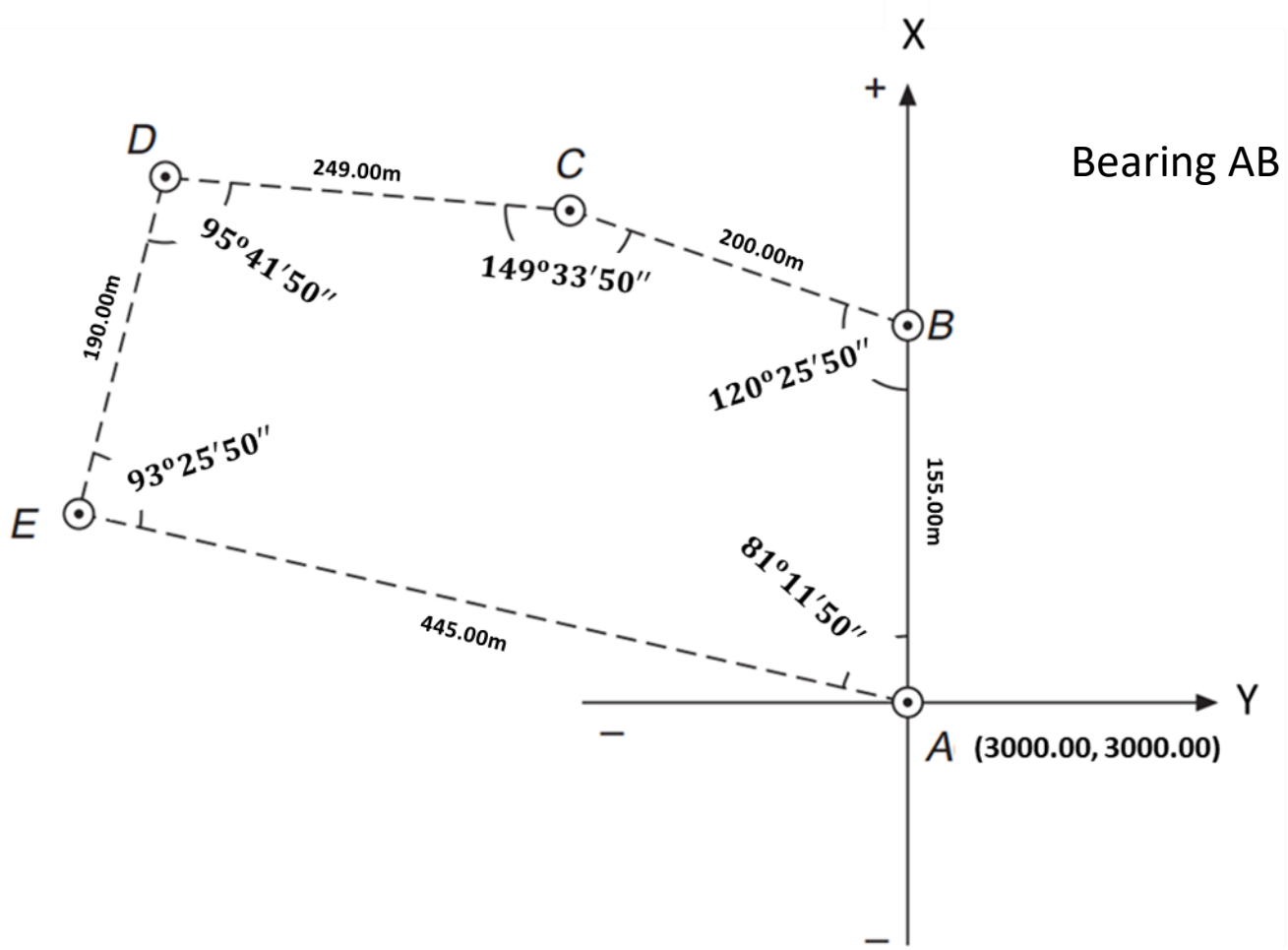
Loop Traverse

- If the traverse formed by the survey lines closes at a station i.e. if the survey lines form a polygon or starts and finishes at the same survey station of the known co-ordinates then the traverse is known as closed traverse.
- A closed traverse is generally used for locating the boundaries or for surveying large areas.



Loop Traverse Computations

- Consider the following loop traverse



Bearing AB = $00^{o}00'00''$

LOOP TRAVERSE (Booking Form)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	

LOOP TRAVERSE (Interior Angles)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50														B
C	BCD	149 33 50														C
D	CDE	95 41 50														D
E	DEA	93 25 50														E
A	EAB	81 11 50														A

Booking interior angles

LOOP TRAVERSE (Sum of Angles)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50														B
C	BCD	149 33 50														C
D	CDE	95 41 50														D
E	DEA	93 25 50														E
A	EAB	81 11 50														A
	Sum =	539 59 10														

The sum of measured angles = $539^o 59' 10''$

Theoretically sum of interior angles = 90^0 x $(2n - 4)$, where n = number of sides of the polygon. In this case n = 5, therefore sum of interior angles should be = 90^0 x $(2(5) - 4) = 540^o\ 00' 00''$

LOOP TRAVERSE (Angular Misclosure)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10													B
C	BCD	149 33 50	+10													C
D	CDE	95 41 50	+10													D
E	DEA	93 25 50	+10													E
A	EAB	81 11 50	+10													A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50													
error =		00 00 -50														

Angular Misclosure = $539^o59'10'' - 540^o00'00'' = -50''$

Correction per angle = 50”/5 angles = 10”

LOOP TRAVERSE (Adjusted Angles)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00												B
C	BCD	149 33 50	+10	149 34 00												C
D	CDE	95 41 50	+10	95 42 00												D
E	DEA	93 25 50	+10	93 26 00												E
A	EAB	81 11 50	+10	81 12 00												A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00												
error =		00 00 -50														

Sum of Corrected angles = $540^o00'00''$

LOOP TRAVERSE (Bearing Calculations)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00										B
C	BCD	149 33 50	+10	149 34 00												C
D	CDE	95 41 50	+10	95 42 00												D
E	DEA	93 25 50	+10	93 26 00												E
A	EAB	81 11 50	+10	81 12 00												A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00												
error =		00 00 -50														

Bearing of line AB = $00^o00'00''$ as the line lies on the X access (see figure)

LOOP TRAVERSE (Bearing Calculations)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00										B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00										C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00										D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00										E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00										A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00												
error =		00 00 -50														

Bearing calculation of other traverse legs

$$\text{Forward Bearing} = \text{Previous Bearing} - 180 + \text{Horizontal Angle}$$

LOOP TRAVERSE (Bearing Calculations)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00										B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00										C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00										D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00										E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00										A
Sum = 539 59 10 90*(2n-4) = - 540 00 00			+50	540 00 00	AB	00 00 00										
error = 00 00 -50																

Initial bearing of line AB = Final bearing of line AB = $00^o00'00''$

LOOP TRAVERSE (Distances)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00									B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00									C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00									D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00									E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00									A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00									
error =		00 00 -50														

Sum of distances (Traverse Legs) = 1239.00

LOOP TRAVERSE (Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00							B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31							C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00							D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06							E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08							A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00									
error =		00 00 -50														

Computation of Partials: $\Delta Y = distance \ \mathbf{x} \ \sin(bearing)$ and $\Delta X = distance \ \mathbf{x} \ \cos(bearing)$

LOOP TRAVERSE (Sum of Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00							B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31							C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00							D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06							E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08							A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	**-0.55**	**-0.83**							
error =		00 00 -50														

Sum of partials should be zero but $\sum \Delta Y = -0.55$ and $\sum \Delta X = -0.83$

That is $e_y = -0.55$ and $e_x = -0.83$. We adjust using Bowditch method.

LOOP TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00							B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31							C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00							D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06							E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08							A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83							
error =		00 00 -50														

Bowditch Corrections: $\frac{-e_y}{\sum_{i=1}^{n} d_i} * d_i = K_y d_i$ $\frac{-e_x}{\sum_{i=1}^{n} d_i} * d_i = K_x d_i$

$K_y = -\left(\frac{-0.55}{1239.00}\right)$ $K_x = -\left(\frac{-0.83}{1239.00}\right)$

LOOP TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07						B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31							C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00							D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06							E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08							A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83							
error =		00 00 -50														

Bowditch Corrections:

$$\Delta Y_B = -\left(\frac{-0.55}{1239.00}\right)(155.00) = 0.07$$

LOOP TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10					B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31							C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00							D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06							E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08							A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83							
error =		00 00 -50														

Bowditch Corrections:

$$\Delta Y_B = -\left(\frac{-0.55}{1239.00}\right)(155.00) = 0.07$$

$$\Delta X_B = -\left(\frac{-0.83}{1239.00}\right)(155.00) = 0.10$$

LOOP TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10					B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13					C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00							D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06							E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08							A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83							
error =		00 00 -50														

Bowditch Corrections:

$$\Delta Y_C = -\left(\frac{-0.55}{1239.00}\right)(200.00) = 0.09$$

$$\Delta X_C = -\left(\frac{-0.83}{1239.00}\right)(200.00) = 0.13$$

LOOP TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10					B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13					C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00	0.11	0.17					D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06	0.08	0.13					E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08	0.20	0.30					A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83	0.55	0.83					
error =		00 00 -50														

Bowditch Corrections:

$$\Delta Y_i = -\left(\frac{-0.55}{1239.00}\right)(d_i)$$

$$\Delta X_i = -\left(\frac{-0.83}{1239.00}\right)(d_i)$$

LOOP TRAVERSE (Adjusted Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10	0.07	155.10			B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13	-172.35	101.44			C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00	0.11	0.17	-248.89	0.17			D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06	0.08	0.13	-18.79	-188.93			E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08	0.20	0.30	439.96	-67.78			A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83	0.55	0.83					
error =		00 00 -50					Correction =	+0.55	+0.83							

Computing adjusted ΔY and ΔX values : Difference in coordinates + adjustments

LOOP TRAVERSE (Sum of Adjusted Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10	0.07	155.10			B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13	-172.35	101.44			C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00	0.11	0.17	-248.89	0.17			D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06	0.08	0.13	-18.79	-188.93			E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08	0.20	0.30	439.96	-67.78			A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83	0.55	0.83	0.00	0.00			
error =		00 00 -50														
						Correction =		+0.55	+0.83							

Note sum of partials equals to zero i.e $\sum \Delta Y = 0.00$ and $\sum \Delta X = 0.00$

LOOP TRAVERSE (Calculation of Coordinates)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10	0.07	155.10	3000.07	3155.10	B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13	-172.35	101.44			C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00	0.11	0.17	-248.89	0.17			D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06	0.08	0.13	-18.79	-188.93			E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08	0.20	0.30	439.96	-67.78			A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83	0.55	0.83	0.00	0.00			
error =		00 00 -50														
						Correction =		+0.55	+0.83							

We compute the coordinates of B that is $Y_B = Y_A + adjusted\ \Delta Y_B$ and $X_B = X_A + adjusted\ \Delta X_B$

LOOP TRAVERSE (Calculation of Coordinates)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10	0.07	155.10	3000.07	3155.10	B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13	-172.35	101.44	2827.72	3256.54	C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00	0.11	0.17	-248.89	0.17	2578.83	3256.71	D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06	0.08	0.13	-18.79	-188.93	2560.04	3067.78	E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08	0.20	0.30	439.96	-67.78	3000.00	3000.00	A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83	0.55	0.83	0.00	0.00			
error =		00 00 -50														
						Correction =		+0.55	+0.83							

We compute coordinates of the other points that is $Y_i = Y_{i-1} + adjusted\ \Delta Y_i$ and $X_i = X_{i-1} + adjusted\ \Delta X_i$

LOOP TRAVERSE (Calculation of Coordinates)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10	0.07	155.10	3000.07	3155.10	B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13	-172.35	101.44	2827.72	3256.54	C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00	0.11	0.17	-248.89	0.17	2578.83	3256.71	D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06	0.08	0.13	-18.79	-188.93	2560.04	3067.78	E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08	0.20	0.30	439.96	-67.78	3000.00	3000.00	A
Sum =		539 59 10														
90*(2n-4) =		- 540 00 00	+50	540 00 00	AB	00 00 00	1239.00	-0.55	-0.83	0.55	0.83	0.00	0.00			
error =		00 00 -50														
						Correction =		+0.55	+0.83							

Note that the initial and final coordinates of A are the same.

LOOP TRAVERSE (Booking Complete)

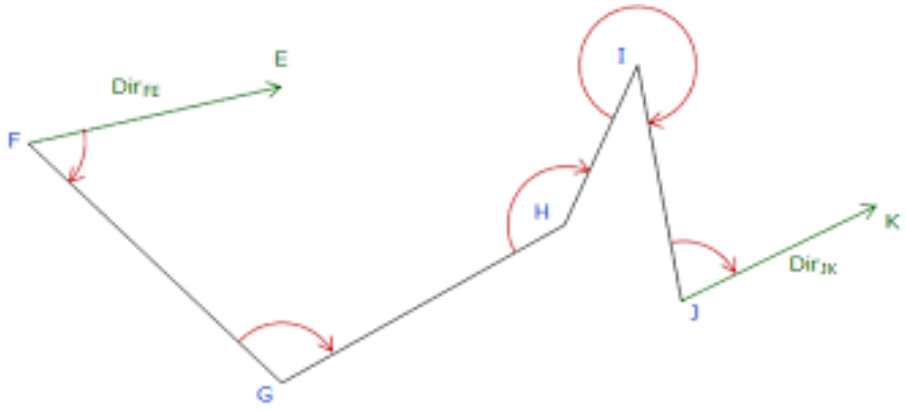
Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length m	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	-	-	-	-	-	-	-	-	-	3000.00	3000.00	A
B	ABC	120 25 50	+10	120 26 00	AB	00 00 00	155.00	0.00	155.00	0.07	0.10	0.07	155.10	3000.07	3155.10	B
C	BCD	149 33 50	+10	149 34 00	BC	300 26 00	200.00	-172.44	101.31	0.09	0.13	-172.35	101.44	2827.72	3256.54	C
D	CDE	95 41 50	+10	95 42 00	CD	270 00 00	249.00	-249.00	0.00	0.11	0.17	-248.89	0.17	2578.83	3256.71	D
E	DEA	93 25 50	+10	93 26 00	DE	185 42 00	190.00	-18.87	-189.06	0.08	0.13	-18.79	-188.93	2560.04	3067.78	E
A	EAB	81 11 50	+10	81 12 00	EA	98 48 00	445.00	439.76	-68.08	0.20	0.30	439.96	-67.78	3000.00	3000.00	A
Sum = 539 59 10 90*(2n-4) = - 540 00 00			+50	540 00 00	AB	00 00 00 Sum =	1239.00	-0.55	-0.83	0.55	0.83	0.00 (Sum)	0.00 (Sum)			
error = 00 00 -50								Correction =		+0.55	+0.83					

Linear Misclosure $= \sqrt{(0.55^2 + 0.83^2)} = 0.99$

Relative Accuracy $= \frac{0.99}{1239.00} = \frac{1}{1252}$

Link Traverse

- A link traverse is the type of traverse where an open type traverse is linked at the ends of an existing traverse so as to form a closed loop or closed traverse.
- The closing line is generally defined by the coordinates at the endpoints which have been determined by the previous survey.



Link Traverse Computations

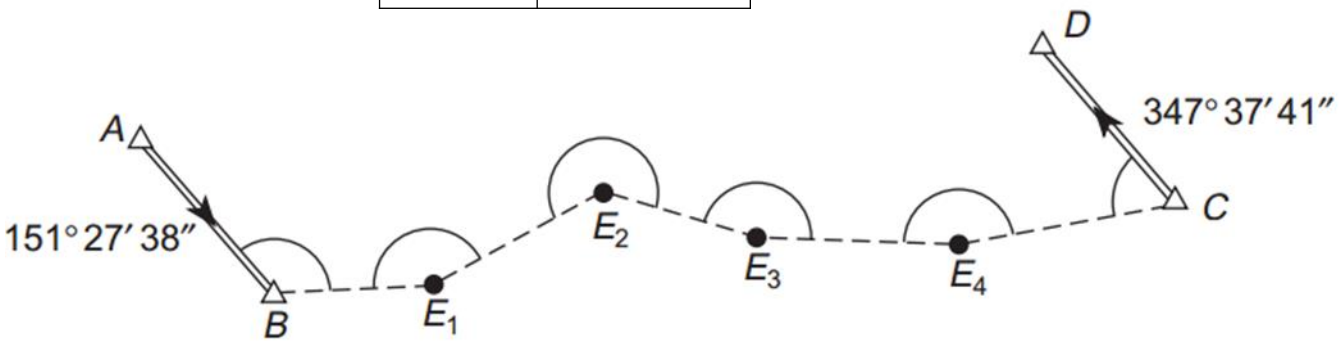
Given the data below determine the coordinates of E1, E2, E3 and E4.

Coordinates		
Point ID	**E (Y)**	**N (X)**
B	3854.28	9372.98
C	7575.56	8503.21

Measured Angles	
Station	**Angle**
B	$143°54'47''$
E1	$149°08'11''$
E2	$224°07'32''$
E3	$157°21'53''$
E4	$167°05'15''$
D	$74°32'48''$

Bearing AB $= 151°27'38''$

Bearing CD $= 347°37'41''$



LINK TRAVERSE (Measured Angles)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-			-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47														E1
E1	B-E1-E2	149 08 11														E2
E2	E1-E2-E3	224 07 32														E3
E3	E2-E3-E4	157 21 53														E4
E4	E3-E4-C	167 05 15														C
C	E4-C-D	74 32 48														

LINK TRAVERSE (Sum of Measured Angles)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-			-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47														E1
E1	B-E1-E2	149 08 11														E2
E2	E1-E2-E3	224 07 32														E3
E3	E2-E3-E4	157 21 53														E4
E4	E3-E4-C	167 05 15														C
C	E4-C-D	74 32 48														
	Sum =	916 10 26														

LINK TRAVERSE (Computed Final Bearing)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-			-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47														E1
E1	B-E1-E2	149 08 11														E2
E2	E1-E2-E3	224 07 32														E3
E3	E2-E3-E4	157 21 53														E4
E4	E3-E4-C	167 05 15														C
C	E4-C-D	74 32 48														
	Sum =	916 10 26														

Computed Final Bearing CD = initial bearing AB + sum of measured angles – (n x 180^o)

Where n = number of measured angles and is positive if even, negative if odd. f the result is negative, add 360^o.

LINK TRAVERSE (Computed Final Bearing)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-			-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47														E1
E1	B-E1-E2	149 08 11														E2
E2	E1-E2-E3	224 07 32														E3
E3	E2-E3-E4	157 21 53														E4
E4	E3-E4-C	167 05 15														C
C	E4-C-D	74 32 48														
	Sum =	916 10 26														

Computed Final Bearing CD $= (151^o 27' 38'' + 916^o 10' 26'') - (6 \text{ x } 180^o) = -12^o 21' 56''$

Computed Final Bearing CD $= -12^o 21' 56'' + 360^o = 347^o 38' 04''$

LINK TRAVERSE (Angular Misclosure)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-			-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47														E1
E1	B-E1-E2	149 08 11														E2
E2	E1-E2-E3	224 07 32														E3
E3	E2-E3-E4	157 21 53														E4
E4	E3-E4-C	167 05 15														C
C	E4-C-D	74 32 48														
	Sum =	916 10 26														

Angular Misclosure = Computed Final Bearing CD – Known Final Bearing

Angular Misclosure $= 347^o\,38'04'' - 347^o\,37'41'' = 23''$

LINK TRAVERSE (Angular Adjustments)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-			-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83													E1
E1	B-E1-E2	149 08 11	-3.83													E2
E2	E1-E2-E3	224 07 32	-3.83													E3
E3	E2-E3-E4	157 21 53	-3.83													E4
E4	E3-E4-C	167 05 15	-3.83													C
C	E4-C-D	74 32 48	-3.83													
	Sum =	916 10 26	-23													
	error =	00 00 23														

Correction per angle = 23”/6 angles = 3.83”

LINK TRAVERSE (Angular Adjustments)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-			-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44												E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07												E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28												E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49												E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11												C
C	E4-C-D	74 32 48	-3.83	74 32 44												
	Sum =	916 10 26	-23													
	error =	00 00 23														

Note that the corrected angles have been rounded off to the nearest second.

Corrected Angles = Observed + Correction

LINK TRAVERSE (Bearing Calculations)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44												E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07												E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28												E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49												E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11												C
C	E4-C-D	74 32 48	-3.83	74 32 44												
	Sum =	916 10 26	-23													
	error =	00 00 23														

Bearing of line A-B $= 151^o27'38''$ (Given)

LINK TRAVERSE (Bearing Calculations)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21										E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07												E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28												E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49												E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11												C
C	E4-C-D	74 32 48	-3.83	74 32 44												
	Sum =	916 10 26	-23													
	error =	00 00 23														

Bearing of line B-E1 $= 151^o 27' 38'' - 180^o + 143^o 54' 47'' = 115^o\, 22' 21''$

LINK TRAVERSE (Bearing Calculations)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21										E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28										E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56										E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45										E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56										C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41										
	Sum =	916 10 26	-23													
	error =	00 00 23														

Bearing calculation of other traverse legs.

$$\text{Forward Bearing} = \text{Previous Bearing} - 180 + \text{Horizontal Angle}$$

LINK TRAVERSE (Bearing Calculations)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21										E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28										E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56										E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45										E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56										C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41										
	Sum =	916 10 26	-23													
	error =	00 00 23														

Note : Computed bearing of line CD = Known bearing of line CD $= 347^o37'41''$

LINK TRAVERSE (Distances)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16									E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92									E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08									E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36									E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35									C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87									
	Sum =	916 10 26	-23													
	error =	00 00 23														

Sum of distances (Traverse Legs) = 3945.87

LINK TRAVERSE (Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02							E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35							E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95							E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16							E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71							C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87									
	Sum =	916 10 26	-23													
	error =	00 00 23														

Computation of Partials: $\Delta Y = distance \text{ x } sin(bearing)$ **and** $\Delta X = distance \text{ x } cos(bearing)$

LINK TRAVERSE (Sum of Computed Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02							E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35							E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95							E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16							E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71							C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48							
	Sum =	916 10 26	-23													
	error =	00 00 23														

Sum of computed partials : $\sum \Delta Y = 3720.79$ and $\sum \Delta X = -869.48$

LINK TRAVERSE (Initial Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02							E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35							E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95							E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16							E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71							C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48							
	Sum =	916 10 26	-23			Initial Partials =		3721.28	-869.77							
	error =	00 00 23														

$$\Delta Y_{C-B} = Y_C - Y_B = 7575.56 - 3854.28 = 3721.28$$

$$\Delta X_{C-B} = X_C - X_B = 8503.21 - 9372.98 = -869.77$$

LINK TRAVERSE (Linear Misclosure)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02							E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35							E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95							E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16							E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71							C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48							
	Sum =	916 10 26	-23			Initial Partials =		3721.28	-869.77							
	error =	00 00 23				Error =		-0.49	+0.29							

$$e_y = \sum \Delta Y - \Delta Y_{C-B} = 3720.79 - 3721.28 = -0.49 \qquad e_x = \sum \Delta X - \Delta X_{C-B} = -869.48 - (-869.77) = 0.29$$

LINK TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02							E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35							E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95							E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16							E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71							C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48							
	Sum =	916 10 26	-23				Initial Partials =	3721.28	-869.77							
	error =	00 00 23					Error =	-0.49	+0.29							

Bowditch Corrections:

$$\frac{-e_y}{\sum_{i=1}^{n} d_i} * d_i = K_y d_i \qquad \frac{-e_x}{\sum_{i=1}^{n} d_i} * d_i = K_x d_i$$

$$K_y = -\left(\frac{-0.49}{3945.87}\right) \qquad K_x = -\left(\frac{0.29}{3945.87}\right)$$

LINK TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05					E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35							E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95							E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16							E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71							C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48							
	Sum =	916 10 26	-23			Initial Partials =		3721.28	-869.77							
	error =	00 00 23				Error =		-0.49	+0.29							

Bowditch Corrections:

$$\Delta Y_i = -\left(\frac{-0.49}{3945.87}\right)(651.16) = 0.08$$

$$\Delta X_i = -\left(\frac{0.29}{3945.87}\right)(651.16) = -0.05$$

LINK TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05					E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35	0.11	-0.06					E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95							E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16							E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71							C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48							
	Sum =	916 10 26	-23			Initial Partials =		3721.28	-869.77							
	error =	00 00 23				Error =		-0.49	+0.29							

Bowditch Corrections:

$$\Delta Y_i = -\left(\frac{-0.49}{3945.87}\right)(870.92) = 0.11$$

$$\Delta X_i = -\left(\frac{0.29}{3945.87}\right)(870.92) = -0.06$$

LINK TRAVERSE (Bowditch Adjustment)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05					E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35	0.11	-0.06					E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95	0.07	-0.04					E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16	0.14	-0.08					E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71	0.10	-0.06					C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48	0.49	-0.29					
	Sum =	916 10 26	-23				Initial Partials =	3721.28	-869.77							
	error =	00 00 23					Error =	-0.49	+0.29							

Bowditch Corrections:

$$\Delta Y_i = -\left(\frac{-0.49}{3945.87}\right)(d_i)$$

$$\Delta X_i = -\left(\frac{0.29}{3945.87}\right)(d_i)$$

LINK TRAVERSE (Adjusted Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05	588.43	-279.07			E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35	0.11	-0.06	867.03	83.29			E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95	0.07	-0.04	407.90	-325.98			E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16	0.14	-0.08	1064.62	-305.24			E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71	0.10	-0.06	793.30	-42.77			C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48	0.49	-0.29					
	Sum =	916 10 26	-23			Initial Partials =		3721.28	-869.77							
	error =	00 00 23				Error =		-0.49	+0.29							

Computing adjusted ΔY and ΔX values : Difference in coordinates + adjustments

LINK TRAVERSE (Sum of Adjusted Partials)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05	588.43	-279.07			E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35	0.11	-0.06	867.03	83.29			E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95	0.07	-0.04	407.90	-325.98			E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16	0.14	-0.08	1064.62	-305.24			E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71	0.10	-0.06	793.30	-42.77			C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48	0.49	-0.29	3721.28	-869.77			
	Sum =	916 10 26	-23				Initial Partials =	3721.28	-869.77							
	error =	00 00 23					Error =	-0.49	+0.29							

Note: sum of adjusted partials $\sum \Delta Y = \Delta Y_{C-B} = 3721.28$ and $\sum \Delta X = \Delta X_{C-B} = -869.77$

LINK TRAVERSE (Calculation of Coordinates)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05	588.43	-279.07	4442.71	9093.91	E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35	0.11	-0.06	867.03	83.29			E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95	0.07	-0.04	407.90	-325.98			E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16	0.14	-0.08	1064.62	-305.24			E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71	0.10	-0.06	793.30	-42.77			C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48	0.49	-0.29	3721.28	-869.77			
	Sum =	916 10 26	-23				Initial Partials =	3721.28	-869.77							
	error =	00 00 23					Error =	-0.49	+0.29							

We compute the coordinates of E1 that is $Y_{E1} = Y_B + adjusted\ \Delta Y_{E1}$ and $X_{E1} = X_B + adjusted\ \Delta X_{E1}$

LINK TRAVERSE (Calculation of Coordinates)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05	588.43	-279.07	4442.71	9093.91	E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35	0.11	-0.06	867.03	83.29	5309.74	9177.20	E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95	0.07	-0.04	407.90	-325.98	5717.64	8851.22	E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16	0.14	-0.08	1064.62	-305.24	6782.26	8545.98	E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71	0.10	-0.06	793.30	-42.77	7575.56	8503.21	C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48	0.49	-0.29	3721.28	-869.77			
	Sum =	916 10 26	-23			Initial Partials =		3721.28	-869.77							
	error =	00 00 23				Error =		-0.49	+0.29							

We compute coordinates of the other points that is $Y_i = Y_{i-1} + adjusted\ \Delta Y_i$ and $X_i = X_{i-1} + adjusted\ \Delta X_i$

LINK TRAVERSE (Booking Complete)

Stn	Angle	Observed Horizontal Angle	Correction	Corrected Horizontal Angle	Line	Bearing	Horizontal Length (m)	Difference in Coordinates		Adjustments		Adjusted Values		Coordinates		Point
		° ' "	"	° ' "		° ' "		ΔY	ΔX	ΔY	ΔX	ΔY	ΔX	Y	X	
A	-	-	-	-	A-B	151 27 38	-	-	-	-	-	-	-	3854.28	9372.98	B
B	A-B-E1	143 54 47	-3.83	143 54 44	B-E1	115 22 21	651.16	588.35	-279.02	0.08	-0.05	588.43	-279.07	4442.71	9093.91	E1
E1	B-E1-E2	149 08 11	-3.83	149 08 07	E1-E2	84 30 28	870.92	866.92	83.35	0.11	-0.06	867.03	83.29	5309.74	9177.20	E2
E2	E1-E2-E3	224 07 32	-3.83	224 07 28	E2-E3	128 37 56	522.08	407.83	-325.95	0.07	-0.04	407.90	-325.98	5717.64	8851.22	E3
E3	E2-E3-E4	157 21 53	-3.83	157 21 49	E3-E4	105 59 45	1107.36	1064.48	-305.16	0.14	-0.08	1064.62	-305.24	6782.26	8545.98	E4
E4	E3-E4-C	167 05 15	-3.83	167 05 11	E4-C	93 04 56	794.35	793.20	-42.71	0.10	-0.06	793.30	-42.77	7575.56	8503.21	C
C	E4-C-D	74 32 48	-3.83	74 32 44	C-D	347 37 41	3945.87	3720.79	-869.48	0.49	-0.29	3721.28	-869.77			
	Sum =	916 10 26	-23			Initial Partials =		3721.28	-869.77							
	error =	00 00 23				Error =		-0.49	+0.29							

$$\textbf{Linear Misclosure} = \sqrt{\left((-0.49)^2+(0.29)^2\right)} = 0.57$$

$$\textbf{Relative Accuracy} = \frac{0.57}{3496} = \frac{1}{6923}$$

END