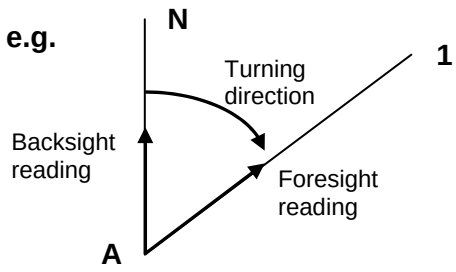
EXAMPLE : OPEN TRAVERSE

Courses of an open traverse with known coordinates of starting and ending points (A and B) are measured. Foresight readings are taken after backsight ones by turning the instrument in clockwise direction. The readings are given as:

Station	Backsight reading	Foresight reading
A	20^g	75^g
1	120^g	340^g
2	50^g	380^g
3	370^g	30^g
4	280^g	130^g



Coordinates: E_A = 170.00 m. N_A = 125.00 m. E_B = 232.60 m. N_B = 121.00 m.

Lengths: S_{A1} = 17 m. S_{12} = 15 m. S_{23} = 28 m. S_{34} = 22 m. S_{4B} = 20 m.

Determine :

a) Angle to the right, azimuth angle, computed latitude-departure and coordinates,
b) Linear misclose at point B,
c) Accuracy of the measurement,
d) Amount of adjustments (dE&dN) in departure and latitude according to compass rule,
e) Adjusted departure and latitude, and then adjusted coordinates.

Pnt	Course	Length (m)	Angle to the right (gon)	Azimuth (gon)	Computed		Computed		Adjustments		Adjusted		Adjusted	
					Departure (m)	Latitude (m)	Easting (m)	Northing (m)	dE (m)	dN (m)	Departure (m)	Latitude (m)	Easting (m)	Northing (m)
A			55				170.00	125.00					170.00	125.00
	A1	17.00		55	12.93	11.04			-0.03	0.05	12.90	11.09		
1			220				182.93	136.04					182.90	136.09
	12	15.00		75	13.86	5.74			-0.03	0.05	13.83	5.79		
2			330				196.79	141.78					196.73	141.88
	23	28.00		205	-2.20	-27.91			-0.06	0.08	-2.26	-27.83		
3			60				194.59	113.87					194.47	114.05
	34	22.00		65	18.76	11.49			-0.04	0.07	18.72	11.56		
4			250				213.35	125.36					213.19	125.61
	4B	20.00		115	19.45	-4.67			-0.04	0.06	19.41	-4.61		
B							232.80	120.69					232.60	121.00
TOTAL		102.00							-0.20	0.31				

a) Angle to the right at point A = Foresight Angle – Backsight Angle = $75 - 20 = 55^g$
Angle to the right at point 1 = Foresight Angle – Backsight Angle = $340 - 120 = 220^g$
Angle to the right at point 2 = Foresight Angle – Backsight Angle = $380 - 50 = 330^g$
Angle to the right at point 3 = Foresight Angle – Backsight Angle = $(30 - 370) + 400 = 60^g$ (since BS>FS)
Angle to the right at point 4 = Foresight Angle – Backsight Angle = $(130 - 280) + 400 = 250^g$ (since BS>FS)

Azimuth of course A1 = Angle to the right at point A = 55^g
Azimuth of course 12 = (Az.A1+Angle to the right at point 1) – 200^g = $(55 + 220) - 200 = 75^g$
Azimuth of course 23 = (Az.12+Angle to the right at point 2) – 200^g = $(75 + 330) - 200 = 205^g$
Azimuth of course 34 = (Az.23+Angle to the right at point 3) – 200^g = $(205 + 60) - 200 = 65^g$
Azimuth of course 4B = (Az.34+Angle to the right at point 4) – 200^g = $(65 + 250) - 200 = 115^g$

Dep.A1 = S_{A1} * Sin (Az.A1) = 17*Sin(55^g) = 12.93 m. Lat.A1 = S_{A1} * Cos (Az.A1) = 17*Cos(55^g) = 11.04 m.
Dep.12 = S_{12} * Sin (Az.12) = 15*Sin(75^g) = 13.86 m. Lat.12 = S_{12} * Cos (Az.12) = 15*Cos(75^g) = 5.74 m.
Dep.23 = S_{23} * Sin (Az.23) = 28*Sin(205^g) = -2.20 m. Lat.23 = S_{23} * Cos (Az.23) = 28*Cos(205^g) = -27.91 m.
Dep.34 = S_{34} * Sin (Az.34) = 22*Sin(65^g) = 18.76 m. Lat.34 = S_{34} * Cos (Az.34) = 22*Cos(65^g) = 11.49 m.
Dep.4B = S_{4B} * Sin (Az.4B) = 20*Sin(115^g) = 19.45 m. Lat.4B = S_{4B} * Cos (Az.4B) = 20*Cos(115^g) = -4.67 m.

$E_1 = E_A$ + Dep.A1 = 170 + 12.93 = 182.93 m. $N_1 = N_A$ + Lat.A1 = 125 + 11.04 = 136.04 m.
$E_2 = E_1$ + Dep.12 = 182.93 + 13.86 = 196.79 m. $N_2 = N_1$ + Lat.12 = 136.04 + 5.74 = 141.78 m.
$E_3 = E_2$ + Dep.23 = 196.79 - 2.20 = 194.59 m. $N_3 = N_2$ + Lat.23 = 141.78 - 27.91 = 113.87 m.
$E_4 = E_3$ + Dep.34 = 194.59 + 18.76 = 213.35 m. $N_4 = N_3$ + Lat.34 = 113.87 + 11.49 = 125.36 m.
$E_B = E_4$ + Dep.4B = 213.35 + 19.45 = 232.80 m. $N_B = N_4$ + Lat.4B = 125.36 - 4.67 = 120.69 m.

b) Linear misclose at B = (Misclose in Dep.^{2} + Misclose in Lat.^{2})$^{1/2}$

Misclose in Dep. = Comp. Dep. of B – Given Dep. of B = 232.80 - 232.60 = 0.20 m.
Misclose in Lat. = Comp. Lat. of B – Given Lat. of B = 120.69 - 121.00 = -0.31 m.
Linear misclose at B = $(0.20^2 + 0.31^2)^{1/2}$ = 0.37 m.

c) Accuracy = 1 / (Total course length/Linear Misclose) = 1 / (102 / 0.37) = 1 / 275

d) dE_{A1} = -Dep.Misc.* ($S_{A1}/\Sigma S$) = -0.20*(17/102) = -0.03 m. dN_{A1} = Lat.Misc.* ($S_{A1}/\Sigma S$) = 0.31*(17/102) = 0.05 m.
dE_{12} = -Dep.Misc.* ($S_{12}/\Sigma S$) = -0.20*(15/102) = -0.03 m. dN_{12} = Lat.Misc.* ($S_{12}/\Sigma S$) = 0.31*(15/102) = 0.05 m.
dE_{23} = -Dep.Misc.* ($S_{23}/\Sigma S$) = -0.20*(28/102) = -0.06 m. dN_{23} = Lat.Misc.* ($S_{23}/\Sigma S$) = 0.31*(28/102) = 0.08 m.
dE_{34} = -Dep.Misc.* ($S_{34}/\Sigma S$) = -0.20*(22/102) = -0.04 m. dN_{34} = Lat.Misc.* ($S_{34}/\Sigma S$) = 0.31*(22/102) = 0.07 m.
dE_{4B} = -Dep.Misc.* ($S_{4B}/\Sigma S$) = -0.20*(20/102) = -0.04 m. dN_{4B} = Lat.Misc.* ($S_{4B}/\Sigma S$) = 0.31*(20/102) = 0.06 m.

e)

Adj.Dep. A1 = Comp.Dep. A1 + dE_{A1} = 12.93 - 0.03 = 12.90 m.	Adj.E_1 = 170.00+12.90 = 182.90 m.
Adj.Lat. A1 = Comp.Lat. A1 + dN_{A1} = 11.04 + 0.05 = 11.09 m.	Adj.N_1 = 125.00+11.09 = 136.09 m.
Adj.Dep. 12 = Comp.Dep. 12 + dE_{12} = 13.86 - 0.03 = 13.83 m.	Adj.E_2 = 182.90+13.83 = 196.73 m.
Adj.Lat. 12 = Comp.Lat. 12 + dN_{12} = 5.74 + 0.05 = 5.79 m.	Adj.N_2 = 136.09+5.79 = 141.88 m.
Adj.Dep. 23 = Comp.Dep. 23 + dE_{23} = -2.20 - 0.06 = -2.26 m.	Adj.E_3 = 196.73-2.26 = 194.47 m.
Adj.Lat. 23 = Comp.Lat. 23 + dN_{23} = -27.91 + 0.08 = -27.83 m.	Adj.N_3 = 141.88-27.83 = 114.05 m.
Adj.Dep. 34 = Comp.Dep. 34 + dE_{34} = 18.76 - 0.04 = 18.72 m.	Adj.E_4 = 194.47+18.72 = 213.19 m.
Adj.Lat. 34 = Comp.Lat. 34 + dN_{34} = 11.49 + 0.07 = 11.56 m.	Adj.N_2 = 114.05+11.56 = 125.61 m.
Adj.Dep. 4B = Comp.Dep. 4B + dE_{4B} = 19.45 - 0.04 = 19.41 m.	Adj.E_B = 213.19+19.41 = 232.60 m.
Adj.Lat. 4B = Comp.Lat. 4B + dN_{4B} = -4.67 + 0.06 = -4.61 m.	Adj.N_B = 125.61-4.61 = 121.00 m.

EXAMPLE : CLOSED TRAVERSE

Angles and distances of a four sided closed traverse are measured in clockwise direction as given. Also the coordinate of point A as 100E and 100N, and the azimuth of side AB as 12.1883^g are given. Compute;

a) Misclose of angles,
b) Adjusted angles,
c) Azimuth of the sides,
d) Linear misclosure, its azimuth and accuracy of measurement,
e) Adjusted coordinates.

Pnt	Side	Length (m)	Angle to the right (gon)	Adjusted angle to the right (gon)	Azimuth (gon)	Depar-ture (m)	Latitude (m)	Com-puted Easting (m)	Com-puted Northing (m)	Adjusted Depar-ture (m)	Adjusted Latitude (m)	Adjusted Easting (m)	Adjusted Northing (m)
A			277.8904^g	277.8935^g				100.00	100.00			100.00	100.00
	AB	87.30			12.1883^g	16.61	85.70			16.63	85.69		
B			289.7284^g	289.7315^g				116.61	185.70			116.63	185.69
	BC	58.45			101.9198^g	58.42	-1.76			58.43	-1.77		
C			299.1775^g	299.1806^g				175.03	183.94			175.06	183.92
	CD	127.48			201.1004^g	-2.20	-127.46			-2.18	-127.48		
D			333.1913^g	333.1944^g				172.83	56.48			172.88	56.44
	DA	84.92			334.2948^g	-72.89	43.57			-72.88	43.56		
A								99.94	100.05			100.00	100.00
TOTAL		358.15	1199.9876^g	1200.00^g		-0.06	0.05	-0.06	0.05	0.00	0.00	0.00	0.00

a) If traverse is worked in clockwise direction, then angle to the right is exterior angle at related point. Therefore sum of these angles should satisfy 200*(n+2). Therefore;

$200^*(4+2) = 1200^g$ Then angular misclose (error) = $1199.9876^g - 1200^g = -0.0124^g$

b) Correction for each angle = $0.0124^g / 4 = 0.0031^g$ (equally distributed)
Adjusted angle = $277.8904^g + 0.0031^g = 277.8935^g$, and the similar calculations for the others.

c) Azimuth of any point = Previous azimuth + Angle to the right – 200^g
Az. BC = $12.1883^g + 289.7315^g - 200^g = 101.9198^g$
Az. CD = $101.9198^g + 299.1806^g - 200^g = 201.1004^g$
Az. DA = $201.1004^g + 333.1944^g - 200^g = 334.2948^g$
Az. AB = $334.2948^g + 277.8935^g - 200^g = 412.1883^g = 12.1883^g$ (to check)

d) Departure = Side length * sin (Az.) Latitude = Side length * cos (Az.)

For AB, Dep.=87.30*sin (12.1883^g) = 16.61 m. Lat.=87.30*cos (12.1883^g) = 85.70 m.
For BC, Dep.=58.45*sin (101.9198^g) = 58.42 m. Lat.=58.45*cos (101.9198^g) = -1.76. m.
For CD, Dep.=127.48*sin (201.1004^g) = -2.20 m. Lat.=127.48*cos (201.1004^g) = -127.46 m.
For DA, Dep.=84.92*sin (334.2948^g) = -72.89 m. Lat.= 84.92*cos (334.2948^g) = 43.57 m.

ΣDeparture = -0.06 m. ΣLatitude = 0.05 m. (Error in closure)
Linear misclose = $[(-0.06)^2 + (0.05)^2]^{1/2} = 0.078$ meter.
Azimuth = $\tan^{-1}$ (ΔDep.)/ (ΔLat.) = $-0.06/0.05 = -55.7716^g$ (if ΔDep "-" and ΔLat. "+", add 400^g), then Azimuth = $-55.7716^g + 400.0000^g = 344.2284^g$
Accuracy = 1 : (358.15/0.078) = 1:4591 = 1:4600

e) Correction according to compas rule (Bodwitch Method)

For side AB; Correction for dep. = ΔDep.*length/total perimeter = 0.06*87.30/358.15 $\cong$ 0.02 m.
Correction for lat. = ΔLat.*length/total perimeter = 0.05*87.30/358.15 $\cong$ -0.01 m.
For side BC; Correction for dep. = ΔDep.*length/total perimeter = 0.06*58.45/358.15 $\cong$ 0.01 m.
Correction for lat. = ΔLat.*length/total perimeter = 0.05*58.45/358.15 $\cong$ -0.01 m.
For side CD; Correction for dep. = ΔDep.*length/total perimeter = 0.06*127.48/358.15 $\cong$ 0.02 m.
Correction for lat. = ΔLat.*length/total perimeter = 0.05*127.48/358.15 $\cong$ -0.02 m.
For side DA; Correction for dep. = ΔDep.*length/total perimeter = 0.06*84.92/358.15 $\cong$ 0.01 m.
Correction for lat. = ΔLat.*length/total perimeter = 0.05*84.92/358.15 $\cong$ -0.01 m.