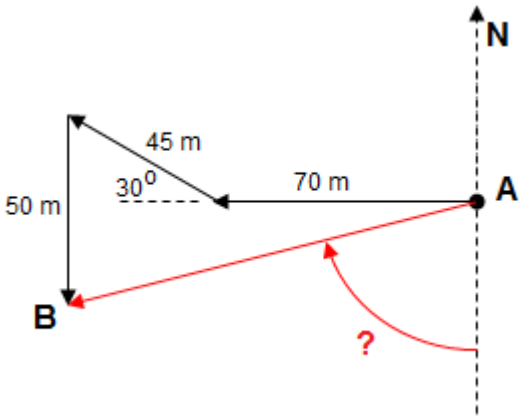
MAD 256 – SURVEYING **April 7th, 2011**
1st MIDTERM EXAM – ANSWERS

(20 p) 1. A person starts to walk from the point A. First he walks 70 m on a straight line towards West, then deflects 30° to the right and walks 45 m and finally directs to South and walks another 50 m. Thus, he reaches to the point B. Determine the horizontal distance between the points A and B in meter and bearing of line AB in degree.

SOLUTION :

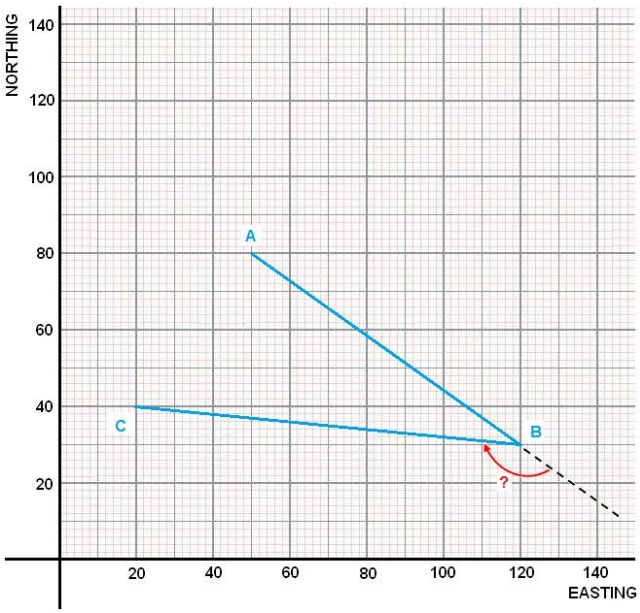
ΔE of line AB = -70-45.cos 30 = -101.82 m
ΔN of line AB = 45.sin 30-50 = -27.5 m
Distance AB = $(\Delta E^2+\Delta N^2)^{1/2}$ = $(101.82^2+27.5^2)^{1/2}$ = **105.47 m**
tan α = $\Delta E/\Delta N$ = -101.82/-27.5 = 3.70 then
α = atan (3.7) = 74.88°
Az_{AB} = 74.88° + 180 = **254.88°**



(20 p) 2. The coordinates of the points ABC (a broken line) are given as follows. Determine the deflection angle at point B in degree unit.

	Coordinates (m)	
Point	Easting	Northing
A	50	80
B	120	30
C	20	40

SOLUTION :



Deflection angle at point B can be determined after finding bearing angles of the lines BC and BA. Then;

α_{BC} = $\tan^{-1}$ ($\Delta E/\Delta N$) = $\tan^{-1}$ [$(E_c-E_B)/(N_c-N_B)$]
= $\tan^{-1}$ [(20-120)/(40-30)]= $\tan^{-1}$ (-100/10)= -84.3°
Bearing BC = N84.3W
α_{BA} = $\tan^{-1}$ ($\Delta E/\Delta N$) = $\tan^{-1}$ [$(E_A-E_B)/(N_A-N_B)$]
= $\tan^{-1}$ [(50-120)/(80-30)] = $\tan^{-1}$ (-70/50)= -54.46°
Bearing BA = N54.46W

Deflection angle at B = 180-(Bea_{BC}-Bea_{BA})
= 180-(84.3°-54.46°) = **150.16°R**

(10 p) 3. Determine the missing parameters in the following questions.

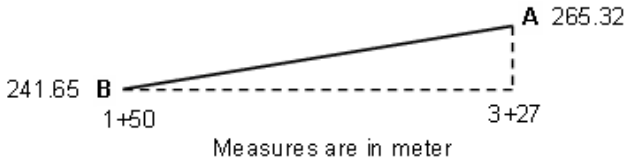
a) Map distance of AB = 10 cm
Field distance of AB = 4 km
The scale of the map = ??

b) The scale of the map = 1/100000
Field distance of CD = 5400 m
Map distance of CD = ?? mm

SOLUTION :

a) Scale = Map length/Field length = 10 cm / 400000 cm = **1/40000**
b) Map length = Field length/Scale = 5400000 mm / 100000 = **54 mm**

(10 p) 4. If the elevations of two points are known as well as the horizontal distance between them, determine the slope in percentage from point A to B.



SOLUTION :

Elevation difference = 241.65-265.32 = -23.67 m (since point B is lower)
Distance = 327-150 = 177 m
Slope (Gradient) = (-23.67/177)*100 = -13.37% or $\tan^{-1}(23.67/177)$ = -7.6 degree

(10 p) 5. Convert the following angles to the corresponding units.

In general, $\frac{D}{360} = \frac{G}{400} = \frac{M}{6400} = \frac{R}{2\pi}$

a) 144^o= ? grade 144*400/360=160 grade
b) $5\pi/8$= ? degree $(5\pi/8)*360/2\pi$=112.5 degree
c) 230^o= ? radian $230*2\pi/360=1.28\pi$ or 4.014 radian
d) 170^g= ? radian $170*2\pi/400=0.85\pi$ or 2.67 radian

(10 p) 6. A horizontal distance was recorded as 342.28 m with a 30-m tape that was 30.006 m under standard conditions. If the temperature was 12^oC during measurement, determine the corrected distance? [use $C_t = 0.0000116(T - 20)L$]

SOLUTION :

Correction per tape length = -error = -(30-30.006) = +0.006 m
Tape correction = (342.28/30)*0.006 = 0.068 m
Temperature correction C_t = 0.0000116(12 - 20)342.28 = -0.032 m
Corrected distance = 342.28+0.068-0.032 = 342.316 m

(10 p) 7. The interior angles of a triangle are measured as $75^o12'16''$, $38^o29'45''$ and $66^o17'38''$. Determine the error in this measurement and then correct the angles.

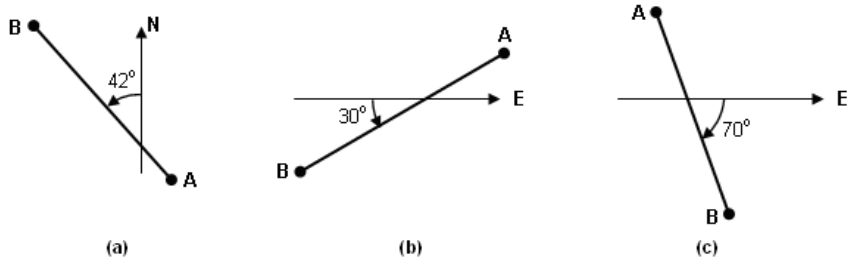
SOLUTION :

Total measured angle = $75^o12'16''+38^o29'45''+66^o17'38'' = 179^o59'39''$
Error = measured-true = $179^o59'39''-180^o = 179^o59'39''-179^o59'60'' = -21''$
Correction for each = -error/3 = -(-21"/3) = +7"
Corrected angles;

$75^o12'16''+7'' = 75^o12'23''$
$38^o29'45''+7'' = 38^o29'52''$
$66^o17'38''+7'' = 66^o17'45''$

$\Sigma = 179^o58'120''=179^o60' = 180^o$

(10 p) 8. Determine the bearing and the azimuth angles of the lines BA in each of the following figures. (Show your drawings and calculations)



a) Azimuth BA = $360-42=318^o$ Bearing (NW quadrant) = N 42^o W
b) Azimuth AB = $180+90^o-30^o= 240^o$ Bearing (SW quadrant) = S 60^o E
c) Azimuth AB = $180^o-(90^o-70^o)= 160^o$ Bearing (SE quadrant) = S 20^o E

MAD 256 – SURVEYING **May 26th, 2011**
2nd MIDTERM EXAM (ANSWERS)

(30 p) 1. The area of a closed five-sided traverse is needed. It was aimed to be determined by triangulating the area. For this purpose a "pole point" for measuring instrument was set-up out of the traverse (tract). At the pole point, North direction is taken as reference line and the angle is adjusted to zero degree in that direction. Afterwards azimuth angles of the lines which connect the pole point to each of the traverse corners were measured (in clockwise direction) as follows.

$Az_{IA} = 240^o$, $Az_{IB} = 220^o$, $Az_{IC} = 255^o$, $Az_{ID} = 270^o$ and $Az_{IE} = 290^o$

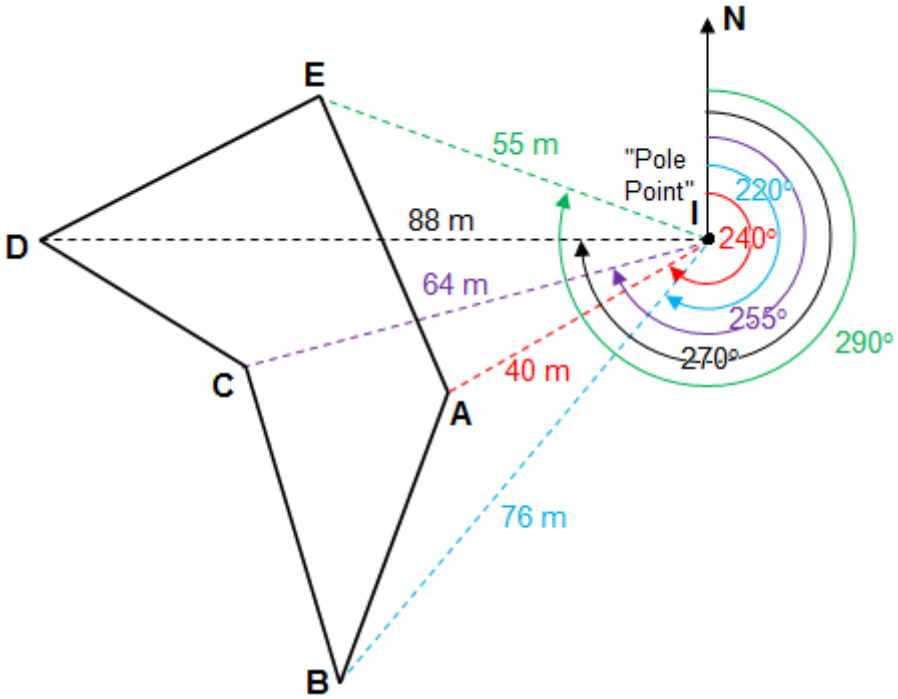
Also the horizontal lengths of these lines were mesured by using a steel tape and the following measures were obtained:

IA = 40 m, IB = 76 m, IC = 64 m, ID = 88 m and IE = 55 m.

According to these measurements, draw the traverse first and then determine its area by using following equation;

Area of a triange = $a.b.\sin\alpha/2$

SOLUTION :



Area IAB = 40x76xSin (240-220)/2 = 519.87 m^2

Area IBC = 76x64xSin (255-220)/2 = 1394.94 m^2

Area ICD = 64x88xSin (270-255)/2 = 728.83 m^2

Area IDE = 88x55xSin (290-270)/2 = 827.69 m^2

Area IAE = 40x55xSin (290-240)/2 = 842.65 m^2

Area of traverse (ABCDE) = (IBC+ICD+IDE)-(IAE+IAB)

= (1394.94+728.83+827.69)-(842.65+519.87) = 2951.46-1362.52 = 1588.94 m^2

(10 p) 2. A closed five-sided field traverse has the following interior angles:

A=117°30'42", B=122°09'30", C=80°10'24", D=90°41'50".

Find the angle at E if angular error of the traverse is -20''.

SOLUTION :

For a five sided traverse the sum of interior angles must provide

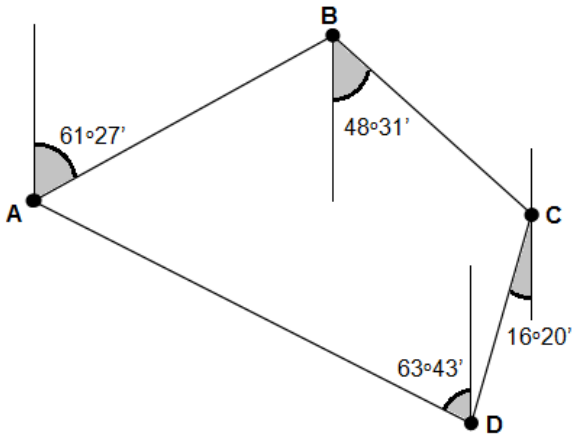
180 (n-2) = 180*3 = 540°

Sum of A, B, C and D = 410°30'146'' = 410°32'26''.

Now angle at E = (539°59'60''-410°32'26'')-20'' = 129°27'14''

(15 p) 3. Closed traverse ABCD has the following bearings:
AB = N 61°27' E, BC = S 48°31' E, CD = S 16°20' W, DA = N 63°43' W.
Compute the interior angles and provide a geometric check on your work. If you find any angular error for interior angles, progress necessary correction.

SOLUTION :



After drawing, interior angles can easily be determined as follows:
at A : 180-(61°27'+63°43') = 54°50'
at B : 61°27'+48°31' = 109°58'
at C : 180-(48°31'+16°20') = 115°9'
at D : 63°43'+16°20' = 80°3'

For geometric check, sum of interior angles must provide 180*(n-2) = 360°

A+B+C+D = 358°120' = 360°

It shows that the interior angles are correct.

(25 p) 4. Calculate the area of following four-sided traverse by using DMD method.

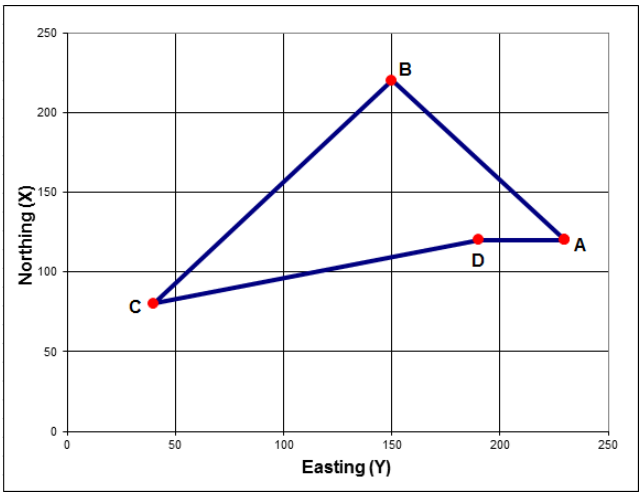
SOLUTION :

	COORDINATES (m)	
Sta.	Northing	Easting
A	120	230
B	220	150
C	80	40
D	120	190

Dep.of AB = 150-230 = -80 (≡ W80) ...m
Lat.of AB = 220-120 = +100 (≡ N100) ...m
Dep.of BC = 40-150 = -110 (≡ W110) ...m
Lat.of BC = 80-220 = -140 (≡ S140) ...m
Dep.of CD = 190-40 = +150 (≡ E150) ...m
Lat.of CD = 120-80 = +40 (≡ N40) ...m
Dep.of DA = 230-190 = +40 (≡ E40) ...m
Lat.of DA = 120-120 = 0 ...m

Point C is the most westerly point. Therefore DMD calculation starts at that point.

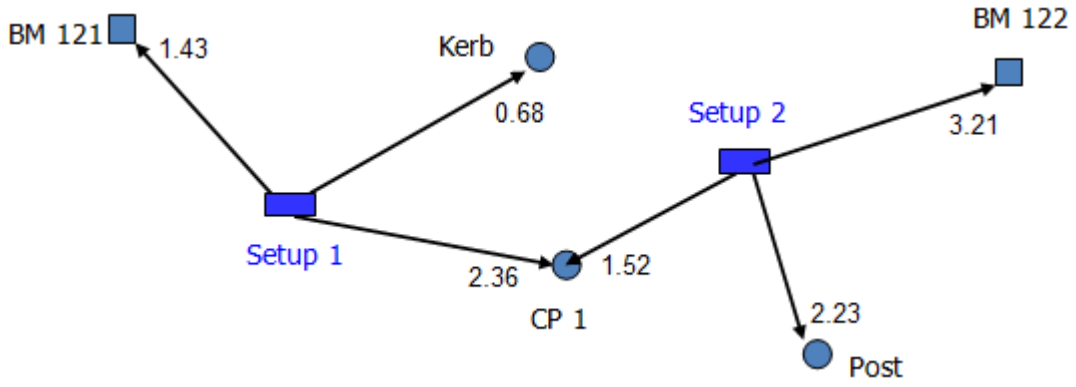
Departure of CD	= + 150	= ***DMD of CD***
Departure of CD	= + 150	
Departure of DA	= + 40	
	+ 340	= ***DMD of DA***
Departure of DA	= + 40	
Departure of AB	= - 80	
	+ 300	= ***DMD of AB***
Departure of AB	= - 80	
Departure of BC	= - 110	
	+ 110	= ***DMD of BC*** Check



				Double Areas	
Course	Latitude	Departure	DMD	+	-
AB	N 100	W 80	+ 300	30000	
BC	S 140	W 110	+ 110		15400
CD	N 40	E 150	+ 150	6000	
DA	0	E 40	+ 340	0	
Total	0.00	0.00		36000	15400

Area = (36000-15400)/2 = 10300 m^2

(20 p) 5. A leveling measurement between BM121 and BM122 was conducted as follows. Rod readings are given. If the elevation of BM121 is 642.73 m, determine the elevations of the other points (Kerb, CP1, Post and BM122).



Back	Inter	Fore	Rise	Fall	RL	Point
1.43					642.73	BM 121
	0.68		0.75		643.48	Kerb
1.52		2.36		1.68	641.80	CP1
	2.23			0.71	641.09	Post
		3.21		0.98	640.11	BM 122
2.95		5.57	0.75	3.37		Σ
		(-2.62)		(-2.62)		Δ

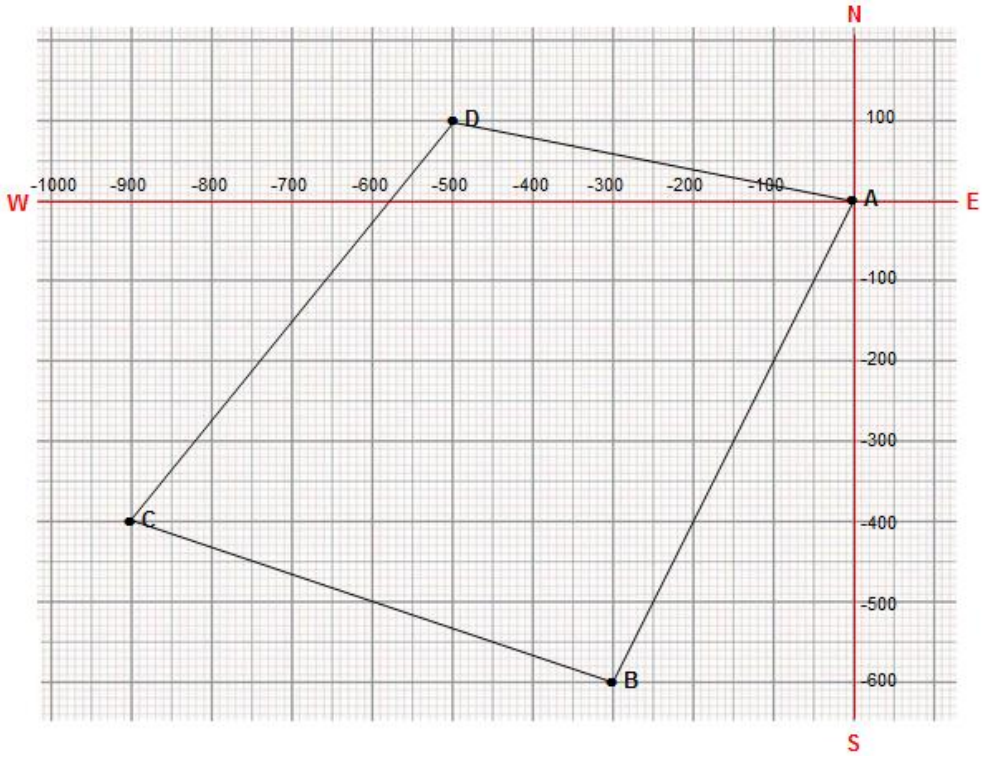
640.11-642.73 = -2.62

MAD 256 – SURVEYING **June 7th, 2011**
FINAL EXAM (ANSWERS)

(20 p) 1. Latitudes and departures of courses (except DA) of a quadrilateral are given. Draw the figure first and then determine its area (m^2) by the DMD method. First decide the most westerly point and then determine DMDs starting from that point. (Attach your drawing to the answer sheets if you do on a millimetric paper)

Course	**AB**	**BC**	**CD**
Latitudes (m)	S600	N200	N500
Departures (m)	W300	W600	E400

SOLUTION :



From drawing, Latitude of DA = S100 Departure of DA = E500

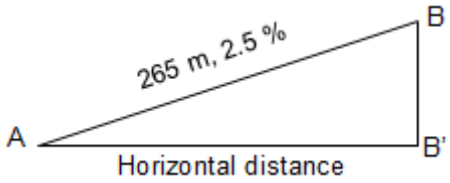
Point C is the most westerly point. Therefore DMD calculation starts at that point.

Departure of CD	= + 400	= ***DMD of CD***
Departure of CD	= + 400	
Departure of DA	= + 500	
	+ 1300	= ***DMD of DA***
Departure of DA	= + 500	
Departure of AB	= - 300	
	+ 1500	= ***DMD of AB***
Departure of AB	= - 300	
Departure of BC	= - 600	
	+ 600	= ***DMD of BC*** Check

				Double Areas	
Course	Latitude	Departure	DMD	+	-
AB	S 600	W 300	+1500		900,000
BC	N 200	W 600	+ 600	120,000	
CD	N 500	E 400	+ 400	200,000	
DA	S 100	E 500	+ 1300		130,000
Total	0.00	0.00		320,000	1,030,000

Area = ABS(-1,030,000+320,000)/2 = 355,000 m^2

(15 p) 2. A slope distance of 265 m was measured on a slope of 1.5%. If the temperature is 12°C and true length of the tape used is 30.004 m, determine the corrected horizontal distance. (Temperature correction, $C_t = 0.0000116(T-20)\times L$



Tape corrected slope distance = (30.004/30)*265 = 265.035 m
%2.5 = $\tan^{-1}$ (2.5/100) = 1.432^o
Horizontal distance = 265.035*Cos 1.432 = 264.952 m (tape corrected horizontal distance.
Temperature correction = 0.0000116 (12-20)*265 = -0.025
Corrected horizontal distance (AB') = 264.952-0.025 = **264.927 m**

(35 p) 3. Courses of an open traverse with known coordinates of starting and ending points (A and B) are measured. Coordinates of A and B and also the lengths and the azimuth angles of the courses are given as follows.

Coordinates: E_A = 120.00 m. N_A = 70.00 m. E_B = 227.00 m. N_B = -79.00 m.

Lengths: S_{A1} = 100 m. S_{12} = 30 m. S_{2B} = 80 m.

Determine :

a) Computed departure-latitude and coordinates of points 1, 2 and B,
b) Linear misclose at point B and accuracy of the measurement,
c) Amount of adjustments (dE&dN) in departure and latitude according to Bowditch rule,
d) Adjusted departure and latitude, and then adjusted coordinates.

Pnt	Course	Length (m)	Azimuth (degree)	Computed		Computed		Adjustments		Adjusted		Adjusted	
				Depar-ture (m)	Latitude (m)	Easting (m)	Northing (m)	dE (m)	dN (m)	Depar-ture (m)	Latitude (m)	Easting (m)	Northing (m)
A						120.000	70.000					120.000	70.000
	A1	100	145	57.358	-81.915			0.355	-0.034	57.713	-81.949		
1						177.358	-11.915					177.713	-11.949
	12	30	70	28.191	10.261			0.107	-0.010	28.297	10.250		
2						205.548	-1.655					206.010	-1.699
	2B	80	165	20.706	-77.274			0.284	-0.027	20.990	-77.301		
B						226.254	-78.929					227.000	-79.000
TOTAL		210		106,254	-148.929			0.746	-0.071	107.000	-149.000		

a) Dep.A1= S_{A1}*Sin (Az.A1) = 100*Sin(145^o)= 57.358 m. Lat.A1= S_{A1}*Cos (Az.A1)= 100*Cos(145^o)= -81.915 m.
Dep.12= S_{12}*Sin (Az.12) = 30*Sin(70^o)= 28.191 m. Lat.12= S_{12}*Cos (Az.12)= 30*Cos(70^o)= 10.261 m.
Dep.2B= S_{2B}*Sin (Az.2B) = 80*Sin(165^o) = 20.706 m. Lat.2B= S_{2B}* Cos (Az.2B)= 80*Cos(165^o) = -77.274 m.
$E_1 = E_A$ + Dep.A1 = 120 + 57.358 = 177.358 m. $N_1 = N_A$ + Lat.A1 = 70 - 81.915 = -11.915 m.
$E_2 = E_1$ + Dep.12 = 177.358 + 28.191 = 205.548 m. $N_2 = N_1$ + Lat.12 = -11.915 + 10.261 = -1.655 m.
$E_B = E_2$ + Dep.2B = 205.548 + 20.706 = 226.254 m. $N_B = N_2$ + Lat.2B = -1.655 - 77.274 = -78.929 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 = 226.254 - 227.00 = -0.746 m.
Misclose in Lat. = Comp. Lat. of B – Given Lat. of B = -78.929 – (-79.00) = 0.071 m.
Linear misclose at B = ($0.746^2 + 0.071^2$)$^{1/2}$ = 0.75 m.
Accuracy = 1 / (Total course length/Linear Misclose) = 1 / (210 / 0.75) = 1 / 280

c) dE_{A1}= -Dep.Misc.* ($S_{A1}/\Sigma S$)= 0.746*(100/210)= 0.355 m. dN_{A1}= -Lat.Misc.* ($S_{A1}/\Sigma S$)= -0.071*(100/210)= -0.034 m.
dE_{12}= -Dep.Misc.* ($S_{12}/\Sigma S$)= 0.746*(30/210)= 0.107 m. dN_{12}= -Lat.Misc.* ($S_{12}/\Sigma S$)= -0.071*(30/210)= -0.010 m.
dE_{2B}= -Dep.Misc.* ($S_{2B}/\Sigma S$)= 0.746*(80/210)= 0.284 m. dN_{2B}= -Lat.Misc.* ($S_{2B}/\Sigma S$)= -0.071*(80/210)= -0.027 m.

d) Adj.Dep. A1 = Comp.Dep. A1 + dE_{A1} = 57.358+0.355 = 57.713 m. Adj.E_1 = 120.00+57.713 = 177.713 m.
Adj.Lat. A1 = Comp.Lat. A1 + dN_{A1} = -81.915-0.034 = -81.949 m. Adj.N_1 = 70.00-81.949 = -11.949 m.
Adj.Dep. 12 = Comp.Dep. 12 + dE_{12} = 28.191+0.107 = 28.297 m. Adj.E_2 = 177.713+28.297 = 206.010 m.
Adj.Lat. 12 = Comp.Lat. 12 + dN_{12} = 10.261-0.01 = 10.250 m. Adj.N_2 = -11.949+10.250 = -1.699 m.
Adj.Dep. 2B = Comp.Dep. 2B + dE_{2B} = 20.706+0.284 = 20.990 m. Adj.E_B = 206.010+20.990 **= 227.00 m.**
Adj.Lat. 2B = Comp.Lat. 2B + dN_{2B} = -77.274-0.027 = -77.301 m. Adj.N_B = -1.699-77.301 **= -79.00 m.**

(15 p) 4. Perform the following conversions.

a) If Azimuth of AB = 340^g, what is Bearing AB = N 60^g W

b) If Vertical angle of AB = -23^o, what is Nadir angle of AB = (90-23) = 67^o

c) If Bearing of AB = S 34^o E, what is Azimuth of AB = (180-34) = 146^o

d) If slope of AB is 3%, what is the slope in degree = atan (3/100) = 1.72^o

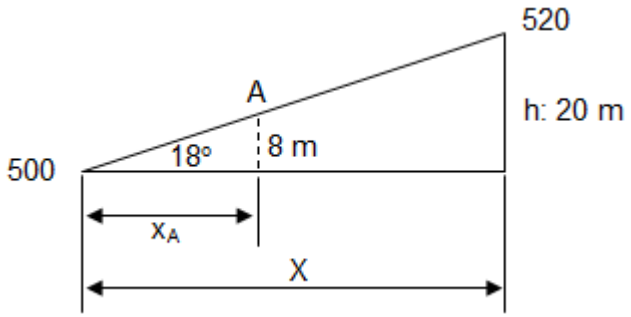
e) If true length of AB is 4000 m and scale of map is 1/50000, what is map length of AB = ?? m

ML/TL = 1/50000 ➔ ML = 4000 m/50000 = 0.08 m

(25 p) 5. A plane is dipping with 18^o in SW direction and it has a strike of 160^o. Elevation of the plane at point A on the following figure was measured 508 m above sea level. Draw the elevation contours of the plane with 20 m intervals and write the elevation values of the contours after drawing in the figure given below. (use the scale 1/2500)

SOLUTION :

First of all, draw an acute triangle on vertical plane according to given information. Then calculate the horizontal distance between contours (X) first and next the horizontal distance of 500 m contour to point A.



X = 20/tan 18 = 61.55 m (scaled length =6155/2500 = 2.46 cm)

$20/61.55=8/X_A$ ➔ X_A = 61.55*8/20 = 24.62 m (scaled length =2462/2500 = 0.98 cm)

