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QARSHI MUHANDISLIK-IQTISODIYOT INSTITUTI

"GEOLOGIYA VA KONCHILIK ISHI" FAKULTETI

"GEODEZIYA, KADASTR VA YERDAN FOYDALANISH" KAFEDRASI

"GEODEZIYA" FANIDAN
kurs ishini bajarish bo'yicha
USLUBIY KO'RSATMA

"Geodeziya, kartografiya va kadastr"
ta'lim yo'nalishining 2-kurs talabalari uchun

MAVZU: POLIGONOMETRIYA YO'LINI TENGLASHTIRISH VA ANIQLIGINI BAHOLASH

QARSHI – 2022

Ushbu Uslubiy ko'rsatma "Geodeziya, kadastr va yerdan foydalanish" kafedrasi (Bayon №___ «___»_____2022___ y) da muhokama etilgan va "Geologiya va konchilik ishi" fakulteti Uslubiy komissiyasiga tavsiya etilgan.

Geologiya va konchilik ishi fakulteti uslubiy komissiyasi (Bayon №___ «___»_____2022___ y) da ko'rib chiqilgan va QMII Uslubiy kengashiga tavsiya etilgan.

Ushbu uslubiy ko'rsatma Qarshi muhandislik iqtisodiyot instituti Uslubiy kengashining "____" "_____" 2022__ yilda bo'lib o'tgan №___- sonli majlisida ko'rib chiqildi va chop etishga tavsiya etildi.

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Mazkur Uslubiy ko'rsatma 5311500 – "Geodeziya, kartografiya va kadastr" ta'limi yo'nalishining 2–kurs talabalari uchun "Geodeziya" fanidan "Poligonometriya yo'lini tenglashtirish va aniqligini baholash" mavzusidagi kurs ishini bajarish bo'yicha ishlab chiqilgan.

# Poligonometriya to'rini tenglashtirish va aniqligini baholash.

Poligonometriya xillari.

Poligonometriya yo'li joyda siniq chiziqlardan iborat bo'lib, tomon uzunliklari va o'ng yoki chap tomon gorizontal burchaklari o'lchanadi. Poligonometriya ko'rinishi bo'yicha 2 xil bo'lib, ochiq yoki yopiq poligonlardan tashkil topgan bo'ladi.

Poligonometriyada burchaklar optik va elektron teodolitlar bilan, masofalar esa har xil asbob uskunalar bilan o'lchanadi.

Poligonometriyada masofa o'lchash usullari.

Svetodal'nomer poligonometriya barcha cinfdagi geodezik to'rlarni barpo qilish va zichlashtirishda, maxsus geodezik to'rlarni barpo qilishda qo'llaniladi. Jumladan: Svetodal'nomer yordamida masofa o'lchash yorug'lik nuri tezligiga asoslangan bo'lib, boshlang'ich nuqtaga svetodal'nomer, oxirgi nuqtaga esa nur qaytargich o'rnatilib, nurning borib qaytishiga sarf bo'lgan vaqt o'lchanadi.
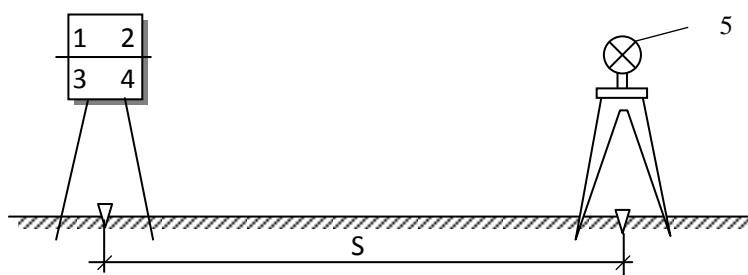

1 – rasm.

bu yerda:
1– vaqt o'lchagich,
2 – nur uzatgich, 3 – klavitura,
4 – nur qabul qilgich uskuna,
5 – nur qaytargich uskuna.

Masofa S quyidagi formula bilan aniqlanadi.

$$S = \frac{v \cdot t}{2}$$

Radiodal'nomer poligonometriya barcha sinfdagi geodezik to'rlarini barpo qilishda qo'llaniladi.

Radiodal'nomer yordamida masofa boshlang'ich va oxirgi nuqtalarga radio stansiya o'rnatilib, to'lqin uzunligi, amplituda va vaqtga asoslanib aniqlanadi.

$$S = f(\tau, f, t)$$
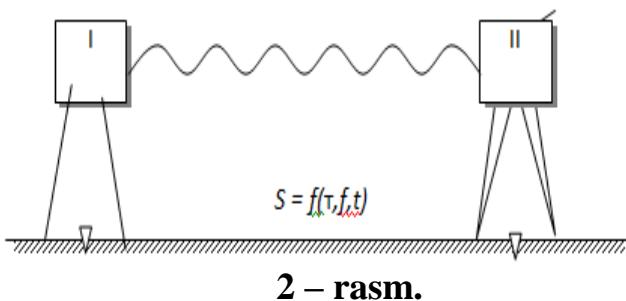
2 – rasm.
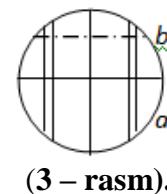
(**3 – rasm**).

$$S = \frac{a - b}{10} ; \text{(m)}$$

Dal'nomer poligonometriya 2 – razryadli to'rlarini barpo qilishda qo'llaniladi, chunki optik dal'nomerlar yordamida masofa o'lchash aniqligi past darajada.

Optik dal'nomer yordamida masofa teodolit–taxeometr, dal'nomer, nivelir ko'rish trubasidagi iplar to'ri yordamida reykadan olingan sanoqlar farqi bo'yicha hisoblanadi (**3 – rasm**).

Bevosita masofa o'lchashda poligonometriya tomoni uzunligi ruletka va maxsus tasmalar yordamida bevosita o'lchanadi.

Qisqa bazisli paralaktik poligonometriya 1 va 2 razryad geodezik to'rlarini barpo qilishda qo'llaniladi. Qisqa bazisli paralaktik usulda masofani o'lchash uchun teodolit va uzunligi 2 metr bo'lgan metall jelzdan goydalaniladi.
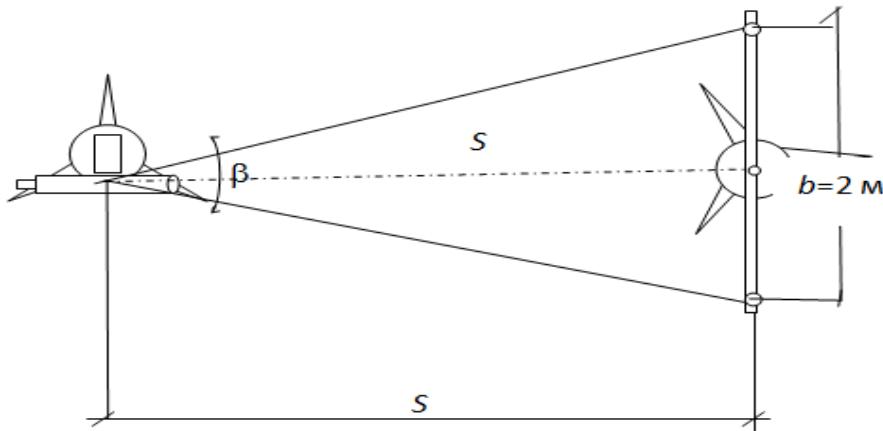
4 – rasm.

$$\frac{b/2}{S} = tg\beta \qquad \frac{b}{2} = S tg\beta \quad \text{bu yerdan} \quad S = \frac{1}{tg\beta} = ctg\beta$$

Ochiq poligonli poligonometriya geodezik tayanch punktlariga tayanib, har xil ko'rinishdagi siniq ciziqlar to'plamidan iborat .
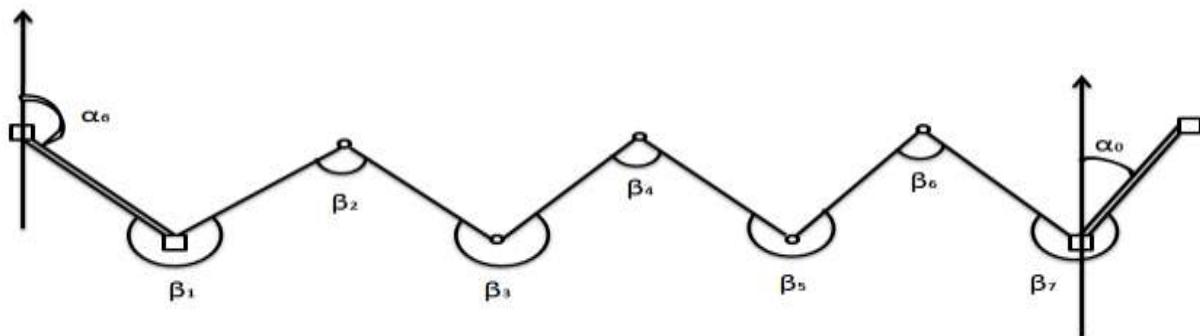
5 – rasm.

Yopiq poligonli poligonometriya bir nuqtadan boshlanib yana o'sha nuqtaga tutashadi. Ichki burchaklar yig'indisi ko'pburchaklar ichki burchaklarining yig'indisi sifatida quyidagi formula yordamida aniqlanadi (6 – rasm). $\Sigma\beta = 180^0 * (n - 2)$;

6 – rasm.

4
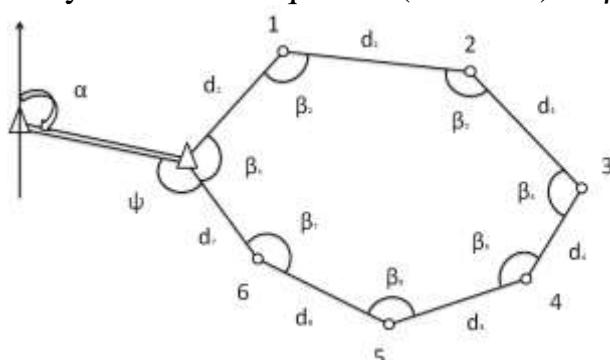
Poligonometriya to'rida qo'llaniladigan o'lchash asboblari.

III sinf poligonometriya to'rida burchak o'lchash aniqligi $1,5^{II}$ ni tashkil etadi. Demak burchaklarni o'lchash uchun juda aniq o'lchaydigan teodolitlardan foydalanish uchun ham masofa o'lchashda svetodal'nomer yoki radiodal'nomer asboblarini qo'llash maqsadga muvofiqdir.

III sinf poligonometriya to'ri bir yoki bir nechta yo'llar orqali II va I sinf poligonometriya to'riga tayanadi. III sinf poligonimetriya tomonining minimal uzunligi – 3 km, poligon perimetri uzunligi 60 km dan ortiq bo'lishi kerak.

1:25000 va 1:10000 masshtabli kartalarni yaratish uchun har 50–60 km^2 ga 1 punkt bo'lishi kerak. 1:5000 masshtabda 20–30 km^2 ga, 1:2000 masshtabda 5–15 km^2 ga 1 та poligonometriya punkti bo'lishi kerak.

Burchaklarni ulchash uchun optik teodolitlardan T1, TБ1, T–05 (Rossiya) va elektron teodolit T2000, T3000 (Shvetsariya) larini qo'llash mumkin.

Masofa o'lchashda "Grant, CT3 (Rossiya), Reynjer VA, Reynjmaster III (AQSh) kabi svetodal'nomerlar, "Luch", MT-A1 (Vengriya), SIAL МД60C, SIAL МД 60S, Дistomat (Shvetsariya), tellurometr GMW20 (Angliya) lar qo'llaniladi.

Poligonometriya to'rini hisoblashda qo'llaniladigan formulalaridagi parametrlarning belgilanishi.

Poligonometriya to'rini hisoblash uchun quyidagi belgilanishlarni qabul qilamiz:

n – poligonometriya tomonlari soni;

S – poligonometriya tomonlari o'rtacha uzunligi;

$T_{б}$, T_0 – poligonometriya boshlang'ich va oxirgi tayanch punktlari;

$\alpha_{б}$, α_0 – poligonometriya boshlang'ich va oxirgi direksion burchaklari;

β – poligonometriya yo'lini chap tomon o'lchangan gorizontal burchaklari;

L – $T_{б}$ va T_0 tayanch punktlari orasidagi masofa;

m_{β} – o'lchangan gorizontal burchak o'rta kvadratik xatosi (o'. k. x);

m_S – tomonlar uzunligi burchak o'rta kvadratik xatosi (o'. k. x);

μ – uzunlik o'lchashda tasodifiy xatoning ta'sir koeffisiyenti;

η – uzunlik o'lchashda sistematik xatoning ta'sir koeffisiyenti;

f_{β} – poligonometriya yo'lining burchak xatoligi;

f_x, f_y, f_s – koordinata Δx va Δy orttirmalari, yo'lning umumiy uzunlik bo'yicha xatosi;

t – yo'lning bo'ylama xatosi;

u – yo'lning ko'ndalang xatosi;

m_t, m_u – yo'lning bo'ylama va ko'ndalang o'rta kvadratik nisbiy xatosi;

$\frac{1}{T}$ – chegaraviy nisbiy xatosi;

m'_u – koordinata orttirmalarini o'lchangan burchaklar bo'yicha hisoblanganda ko'ndalang o'rta kvadratik xatosi.
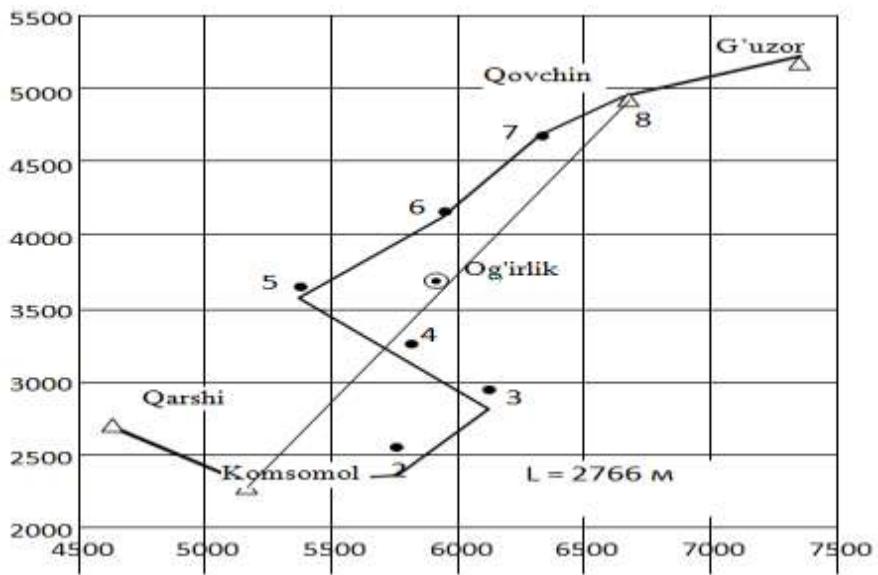
7-rasm. Poligonomtriya to'rining sxemasi.

Poligonometriya to'rini parametrik usulda tenglashtirish va aniqligini baholash.

Komsomol va Qovchin poligonometriya punktlari orasidagi poligono-metriya to'rini tenglashtirishni misol tariqasida ko'rib chiqamiz. Chap o'lchan-gan burilish burchak (β_i)lari va tomonlar uzunlik (S_i)lari, hamda tayanch punkt koordinatalari quyidagi 1– chi va 2– chi jadvallarida keltirilgan.

Burchaklar va tomon uzunliklari qiymatlari.

1–Jadval.

Punktlar.	Burilish burchaklari (chap), β	Masofa uzunligi, S, м	Dala aniqliklari.
Komsomol, 1	179° 38' 43"		
		500,216	
2	205° 14' 48"		
		730,983	
3	183° 25' 28"		
		731,805	
4	190° 31' 25"		
		483,115	$\mu = \pm 0,0002$
5	78° 16' 17"		$\lambda = 0,000008$
		450,208	$m_\mu = \pm 3",5$
6	178° 28' 14"		
		381,973	
7	181° 35' 25"		
		400,252	
8	268° 31' 02"		
		538,444	
9	175° 44' 33"		
		489,866	
Qovchin, 10	210° 53' 39"		

6

Direksion burchaklar.		Koordinatalar (m).			
Qarshi – Komsomol	Qovchin – G'uzor	Komsomol.		Qovchin.	
		X_K	Y_K	X_Q	Y_Q
$74^0 10^I 55^{II}$	$126^0 30^I 43^{II}$	6385,808	4108	7132,814	7719,4346

Poligonometriya to'rini tenglashtirish uchun quyidagi matematik amallar bilan hisoblash ishlarini bajaramiz:

1. O'lchangan β_i burchaklarini 3–jadval (2–ustuniga) yig'amiz, ya'ni uning so'mmasi

$$\sum_1^{n+1} \beta_i = 1852^0 19^I 34^{II} ;$$

bo'ladi.

2. Burchak xatoligini quyidagi formula bilan hisoblaymiz, ya'ni:

$$f_\beta = \alpha_{bosh} + \sum_1^{n+1} \beta_i - (n+1) \cdot 180^0 - \alpha_{oxir}; \qquad (1)$$

bu yerda: α_{bosh} va α_{oxir} – boshlang'ich va oxirgi tomonlar direksion burchaklari, ya'ni: $\alpha_{bosh.} = 74^0 10^I 55^{II}$, $\alpha_{oxir} = 126^0 30^I 43^{II}$; 1 – chi formulaga muvofiq,

$$f_\beta = 74^0 10^I 55^{II} + 1852^0 19^I 34^{II} - 10*180^0 - 126^0 30^I 43^{II} = -14^{II};$$

$$f_\beta^{chekli} = 2*m_\beta \sqrt{n+1} = 7^{II} \sqrt{10} = 22^{II},13$$

$$f_\beta < f_\beta^{chekli};$$

3. Qilingan f_β xatolikni teskari ishora bilan o'lchangan burilish burchaklariga tarqatamiz (3–jadval, 2–chi ustun).

4. Boshlang'ich va oxirgi tomonlar direksion burchaklarining qiymatlari tegishli Qarshi – Komsomol va Qovchin – G'uzor tomonlari (8–rasm) bo'yicha hisoblanadi va 3 – chi jadvalga kiritilib, qolgan tomonlar direksion burchaklari quyidagi formula yordamida aniqlanadi.

$$\alpha_{n,n+1} = \alpha_{n-1,n} - 180^0 + \beta_i ; \qquad (2)$$
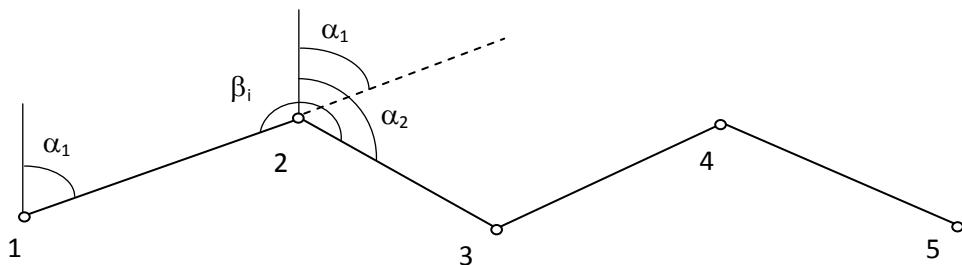
8 – rasm.

5. Koordinata orttirmalari quyidagi formulalar bo'yicha hisoblanadi.

$$\Delta x = S*\cos\alpha ;$$

$$\Delta y = S*\sin\alpha.$$

Olingan natijalar 3– chi jadvalning 5– chi va 6– chi ustunlariga kiritilib yoziladi.

6. Koordinata orttirmalari xatoliklarini quyidagi formulalar bo'yicha hisoblab chiqaramiz.

$$f_x = [\Delta x'] - (x_{oxir} - x_{bosh}) = 747{,}18 - 747{,}186 = -0{,}006 \text{ m};$$

$$f_y = [\Delta y'] - (y_{oxir} - y_{bosh}) = 3611{,}12 - 3611{,}095 = +0{,}025 \text{ m},$$

bu yerda: x_{oxir} va y_{oxir} – oxirgi nuqtalar koordinatalari,
    x_{bosh} va y_{bosh} – boshlang'ich nuqtalar koordinatalari.

7. Uzunlik bo'yicha xatolik quyidagi shartni bajarishi kerak.

$$f_s = \pm\sqrt{f_x^2 + f_y^2} < f_S^{chek} = 2M;$$

$$M^2 = \mu^2[S] + \lambda^2 L^2 + \frac{m_\beta^2}{\rho^2} L^2 \frac{(n+3)}{12}$$

$$f_s = \sqrt{(-0{,}6)^2 + (2{,}5)^2} = 2{,}5 \text{ см} = 0{,}025 \text{ м}.$$

$$\frac{f_s}{4706{,}862} = \frac{0{,}25}{4706{,}862} = \frac{1}{188274{,}48} < \frac{1}{T} = \frac{1}{25000}$$

8. f_x va f_y xatolarini teskari ishora bilan tarqatib Δx va Δy qiymatlarini hisoblaymiz.

9. Poligonometriya nuqtalarining koordinatalarini quyidagi formula yordamida hisoblaymiz.

$$\left.\begin{array}{l} x_i = x_{i\text{-}1} + \Delta x \\ y_i = y_{i\text{-}1} + \Delta y \end{array}\right\} \tag{3}$$

Olingan natijalarni 3 – jadvalning 9 – chi va 10 – chi ustunlariga yozamiz.

Poligonometriya nuqtalarining koordinatalarini hisoblash qaytnomasi.

3–jadval.

Punktlar	Burilish burchaklari	Direksion burchaklar	Tomon uzunliklari	Koordinata orttirmalaria.				Koordinatalar.	
				$\Delta x'$	$\Delta y'$	Δx	Δy		
1	2	3	4	5	6	7	8	9	10
Qarshi	+2	74° 10' 55"							
Komsomol, 1	179° 38' 43"			+0,001	-0,003			6385,808	4108
	+2	73° 49' 40"	500,216	139,322	480,421	139,323	480,418		
2	205° 14' 48"			+0,001	-0,003			6525,131	4588,418
	+2	99° 04' 30"	730,983	-115,295	721,833	-115,294	721,830		
3	183° 25' 28"			+0,001	-0,003			6409,837	5310,248
	+2	102° 30' 00"	731,805	-158,391	714,458	-158,390	714,455		
4	190° 31' 25"			+0,001	-0,003			6251,447	6024,703
	+1	113° 01' 27"	483,115	-188,955	444,630	-188,954	444,627		
5	78° 16' 17"				-0,003			6062,493	6469,330
	+1	11° 17' 45"	450,208	441,486	88,184	441,486	88,181		
6	178° 28' 14"				-0,003			6503,979	6557,511
	+1	9° 46' 00"	381,973	376,890	64,796	376,890	64,793		
7	181° 35' 25"				-0,003			6880,869	6622,304
	+1	11° 21' 26"	400,252	392,414	78,819	392,414	78,816		
8	268° 31' 02"			+0,001	-0,002			7273,283	6701,120
	+1	99°52' 29"	538,444	-92,340	530,466	-92,339	530,464		
9	175° 44' 33"			+0,001	-0,002			7180,944	7231,584
	+1	95° 37' 03"	489,866	-47,951	487,513	-47,950	487,511		
Qovchin, 10	210° 53' 39"							7132,994	7719,095
G'uzor		126° 30' 43"							
$\sum_{1}^{n+1}\beta_i = 1852^0 19^I 34^{II}$			$\Sigma S_i=$ 4706,862 $L = 3750$	$\Sigma\Delta x' =$ 747,18	$\Sigma\Delta y' =$ 3611,12	$\Sigma\Delta x =$ 747,24	$\Sigma\Delta y =$ 3611,095		

$$f_\beta = \alpha_{bosh} + \sum_1^n \beta_i - (n+1)*180^0 - \alpha_{oxir} = -14", \qquad f_x = -0,006, \qquad f_y = +0,025, \qquad f_s = 0,25; \qquad \frac{f_s}{S} = \frac{1}{188274,48} < \frac{1}{25000}$$

9

Poligonometriya yo'lini tenglashtirish qaydnomasi.

Punkt-lar.	Shartli koordinatalar		ξ	η	ξ^2	$\xi\cdot\eta$	η^2	$\Delta x\cdot\cos\alpha$	$\Delta y\cdot\cos\alpha$ = $\Delta x\cdot\sin\alpha$	$\Delta y\cdot\sin\alpha$
	x'	y'								
1	2	3	4	5	6	7	8	9	10	11
1	385	108	25	-324,9	625	-8122,5	105560,01			
								38,805	133,809	461,407
2	525	588	165	155,1	2722,5	25591,5	24056,01			
								18,185	-113,852	712,79
3	409	310	49	-122,9	2401	-6022,1	15104,41			
								34,281	-154,636	-697 ,519
4	251	24	-109	-408,9	11881	4457,01	167199,21			
								73,903	-173,902	409,207
5	62	469	-298	-36,1	88804	-10757,8	88804			
								432,933	86,472	17,272
6	503	557	143	124,1	20449	17746,3	20449			
								371,427	63,853	10,991
7	880	622	520	189,1	270400	98332	270400			
								384,729	77,272	15,520
8	273	701	-87	268,1	7569	-23324,7	71877,61			
								15,835	-90,971	522,605
9	180	231	-180	-201,9	32400	36342	40763,61			
								61,693	-47,720	485,169
10	132	719	-228	286,1	51984	65230,8	81853,21			
	3600	**4329**	+902 -902 0	+1058,6 -1058,6 +4	513738	239585,6	886067,07	1374,791	-219,675	3332,48

$x_м$=1567; $y_м$=888 $[\xi^2]$ $[\xi\cdot\eta]$ $[\eta^2]$

$$[D^2_{ц.i}] = [\xi^2] + [\eta^2] = 1399805,07;$$

10. Poligonometriya nuqtalarining og'irlik markazi koordinatalarini quyidagi formula bo'yicha hisoblab chiqaramiz.

$$X_M = \frac{[x'_i]}{n+1} = \frac{3600}{10} = 360m; \qquad Y_M = \frac{[y'_i]}{n+1} = \frac{4329}{10} = 432,9m;$$

bu yerda: $[x_i]$ = 3600 m, $[y_i]$ = 4329 m –shartli koordinatalar so'mmasi (4-jadval, 2 va 3 ustunlar yig'indisi).

11. Og'irlik markazidan nuqtalargacha bo'lgan masofalarni quyidagi formulalar orqali aniqlaymiz.

$$\xi_i = x'_i - x_м \qquad \eta_i = y'_i - y_м$$

Tekshirish: $[\xi_i] \approx 0$ va $[\eta_i] \approx 0$

12. Poligonometriya yo'lining shartli tenglamasi quyidagicha:

$$\left.\begin{array}{l}[v''_\beta] = 0 \\[6pt] [v_s \cos\alpha] + \dfrac{1}{\rho}[v''_\beta\eta] + f_x = 0 \\[6pt] [v_s \sin\alpha] - \dfrac{1}{\rho}[v''\beta\xi] + f_y = 0\end{array}\right\} \qquad (4)$$

bu yerda: $v_\beta^"$ - o'lchangan burchaklar uchun kiritiladigan ikkinchi tuzatma.

13. Tomon va burchaklar vazni quyidagicha hisoblanadi.

$$p_{s_i} = \frac{1}{S_i}; \quad p_{\beta_i} = \frac{\mu^2}{m_\beta^2} = p; \qquad p = \frac{0,0002^2}{3,5^2} = 3 \cdot 10^{-9}; \qquad q = \frac{1}{p \cdot \rho} = \frac{1}{3 \cdot 10^{-9} \cdot 206265^"} = 1616$$

q – teskari vazn, ρ - radianning sekundagi miqdori, ya'ni

$$\rho = \frac{180^0}{\pi} = 57^0_,29578 = 206264^"_,8$$

14. Korrelat normal tenglamalari koeffisiyentlari.

$$\left.\begin{array}{l} \left[\dfrac{aa}{p}\right] = \dfrac{n+1}{p}, \\[2mm] \left[\dfrac{ab}{p}\right] = q[\eta] = 0, \\[2mm] \left[\dfrac{ac}{p}\right] = -q[\xi] = 0, \\[2mm] \left[\dfrac{bb}{p}\right] = \dfrac{q}{\rho}\left[\eta^2\right] + [\Delta x \cos\alpha] = A \\[2mm] \left[\dfrac{bc}{p}\right] = -\dfrac{q}{\rho}[\eta\xi] + [\Delta x \sin\alpha] = C \\[2mm] \left[\dfrac{cc}{p}\right] = \dfrac{q}{\rho}\left[\xi^2\right] + [\Delta y \cdot \sin\alpha] = B \end{array}\right\} \qquad (5)$$

bu yerda: $q = \dfrac{1}{p * \rho^"}$

15. Tekshirish:

$$\left[(\eta+\xi)^2\right] = \left[\eta^2\right] + \left[\xi^2\right] + 2[\eta\xi]$$

$$\Delta x_i \cos\alpha_i + \Delta y_i \sin\alpha_i = S_i$$

$$\Delta x_i \sin\alpha_i = \Delta y_i \cos\alpha_i$$

16. Normal tenglama ko'rinishida quyidagicha bo'ladi.

$$\left.\begin{array}{l} \dfrac{n+1}{P}k_1 + q[\eta]k_2 + q[\xi]k_3 = 0 \\[2mm] q[\eta]k_1 + Ak_2 + Ck_3 + f_x = 0 \\[2mm] q[\xi]k_1 + Ck_2 + Bk_3 + f_y = 0 \end{array}\right\} \qquad (6)$$

yoki,

$$\left.\begin{array}{l} \dfrac{8}{p} * k_1 = 0 \\[2mm] Ak_2 + Ck_3 + f_x = 0 \\[2mm] Ck_2 + Bk_3 + f_y = 0 \end{array}\right\}$$

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bu yerdan

$$k_1 = 0$$
$$k_2 = \frac{1}{N}(Cf_y - Bf_x)$$
$$k_3 = \frac{1}{N}(Cf_x - Af_y)$$

(7)

$$N = AB - C^2$$

4 chi formulalarga muvofiq:

$$A = \frac{q}{\rho}\eta^2 + \nabla x \cos \alpha$$

$$C = \frac{-q}{\rho}\eta\varepsilon + \nabla x \sin \alpha$$

$$B = \frac{q}{\rho}\varepsilon^2 + \nabla y \sin \alpha$$

$$A = 0,00783 * 886067,07 + 1374,791 = 8316,9448$$
$$C = -0,00783 * 239585,6 + 3332,48 = 1455.376$$
$$B = 0,00783 * 513738 + 3332,48 = 7357,5119$$
$$N = AB - C^2 = 8316,9448 - 7357.5119 = 59073901.04$$

17. Olingan natijalarni 6 – formulaga quyidagilarni hisoblaymiz.

$$k_1 = 0$$

$$k_2 = \frac{(1455,376) * 0,025 - 7357,5119 * (-0,006)}{59073901,04} = \frac{36,38 + 44,14}{59073901,04} = 1,3 \cdot 10^{-7} = 0,0000013$$

$$k_3 = \frac{(1455,376) * (-0,006) - 8316,9448 * (0,025)}{59073901,04} = \frac{8,73 - 207,92}{59073901,04} = -3,6 \cdot 10^{-6} = 0,0000036$$

18. O'lchangan burchak, direksion burchak va tomonlarga tuzatmalar quyidagi formulalar yordamida hisoblanadi.

$$v_{\beta_i}'' = \eta_i q k_2 - \xi_i q k_3$$
$$v_{\alpha_i}'' = \sum_{i}^{n+1} v_{\beta_i}''$$
$$v_{S_i}'' = \Delta x_i k_2 + \Delta y_i k_3$$

(8)

Hisoblangan natijalar 5 – chi jadvalning (3 – 9) ustunlariga kiritiladi.

19. Hisoblangan natijalarni tekshirish:

$$\left[v_{\beta_i}''\right] = 0$$

$$\left[v_{S_i}''\right] = [\Delta x]k_2 + [\Delta y]k_3$$

$$\left[v_{si}''\right] = 747,18 * 0,00000013 + 3611,12 * (-0,0000036)$$

$$0,025 = 0,0000971334 - 0,013000032$$

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20. Koordinata orttirmalariga kiritiladigan tuzatma quyidagi formula yordamida hisoblanadi.

$$\left. \begin{array}{l} v_{\Delta x} = v_s'' * \cos\alpha - \dfrac{v_\alpha''}{\rho}\Delta y_i \\[2mm] v_{\Delta y} = v_s'' * \sin\alpha - \dfrac{v_\alpha''}{\rho}\Delta x_i \end{array} \right\} \tag{9}$$

21. Tekshirish.

$$[v_{\Delta x}] = -f_x \qquad \text{va} \qquad [v_{\Delta y}] = -f_y \tag{10}$$

22. Vazn birligi o'rta kvadraik xatoligi quyidagi formula yordamida hisoblanadi.

$$\mu = \pm\sqrt{\dfrac{P\dfrac{f_\beta^2}{n+1} + P\left[v_\beta''^2\right] + \left[\dfrac{1}{S}v_s^2\right]}{3}}; \tag{11}$$

23. Poligonometriya yo'li tenglashtirilgan elementlari funksiyalarining o'rtacha kvadratik xatoligi quyidagi formula yordamida hisoblanadi.

$$M_u = \mu\sqrt{\dfrac{1}{P_u}}; \tag{12}$$

bu yerda: μ – vazn birligi o'rta kvadratik xatoligi;

$\dfrac{1}{P_u}$ - funksiyaning teskari vazni, u quyidagi formula bilan hisoblanadi.

$$\dfrac{1}{P_u} = \left[\dfrac{EF}{P}\right] - P\dfrac{\left[\dfrac{aF}{p}\right]^2}{n+1} - \dfrac{\left[\dfrac{bF}{p}\right]^2}{A} - \dfrac{\left\{\left[\dfrac{cF}{p}\right] - \dfrac{C}{A}\left[\dfrac{bF}{p}\right]^2\right\}}{B - \dfrac{C^2}{A}}; \tag{13}$$

Poligonometriya yo'li nuqtalarining koordinatalari, direksion burchaklari, tomonlarining o'rta kvadratik xatoliklari va teskari vaznlarini hisoblash formulalari 5 –jadvalda berilgan. 5 – jadval uchun kerak bo'lgan ma'lumotlar:

$\lambda = 0,000013$ $\quad A = +8316$

$\mu = 0,0002$ $\quad C = +1455$ $\qquad 1000\dfrac{q}{\rho} = 0,5876$ $\qquad \dfrac{AB}{1000} = +15673$

$m_\beta = 3,5''$ $\quad B = +7357$

$\rho = 3*10^{-9}$ $\quad N = 59073901$ $\qquad -\dfrac{C^2}{1000} = -2117$ $\qquad \dfrac{N}{1000} = +5907$

$q = 1616,044$

№	Q	$\eta_i qk_2$	$\xi_i qk_3$	v''_{β_i}	v''_{α_i}	$\Delta x_i k_2 \cdot 1000$	$\Delta y_i k_3 \cdot 1000$	v''_s (мм)
1	2	3	4	5	6	7	8	9
1	1616	0,068	-0,145	0,213				
					0,213	0,018	-1,729	-1,711
2	1616	0,032	-0,959	0,991				
					1,204	-0,015	-2,598	-2,613
3	1616	-0,026	-0,285	0,259				
					1,463	-0,02	-2,572	-2,592
4	1616	-0,086	0,634	0,72				
					2,183	-0,024	-1,6	-1,624
5	1616	0,0076	1,73	-1,722				
					0,461	0,057	-0,317	-0,26
6	1616	0,026	-0,831	0,109				
					0,57	0,049	-0,233	-0,184
7	1616	0,040	-3,025	3,065				
					3,635	0,051	-0,283	-0,232
8	1616	0,056	0,506	-0,45				
					3,185	-0,012	-1,909	-1,921
9	1616	-0,042	1,047	-1,089				
					2,096	-0,006	-1,75	-1,756
10	1616	0,06	1,326	-1,266		0,098	12,991	12,893

$$[v_{\beta i}] = 0 \qquad [v_s] = 0 \qquad 0,025 \text{ mm};$$

$Cf_y= +36$ _ $Cf_X= +8$

$-Bf_x= -44$ $Af_y= 207$

$\overline{Cf_y - Bf_x = -8}$ $\overline{Cf_X - Af_y = -199}$

$1000k_2 = 0,00013$ $1000k_3 = 0,0036$

$qk_2 = 0,0021$ $qk_3 = 0,0058$

$\dfrac{v''_\alpha}{\rho} * 1000$	$v''_s * \cos\alpha$	$\dfrac{v''_\alpha}{\rho} * \Delta y * 1000$	Tuzatma $v_{\Delta x}$	$v''_s * \sin\alpha$	$\dfrac{v''_\alpha}{\rho} * \Delta x * 1000$	Tuzatma $v_{\Delta y}$
10	11	12	13	14	15	16
0,00103	-0,476	0,4948	-0,476	-1,643	0,1435	-1,643
0,00583	0,412	4,208	0,407	-2,580	-0,672	-2,580
0,00709	0,561	5,065	0,555	-2,530	-1,122	-2,531
0,01058	0,635	4,7041	0,6302	-1,494	-1,999	-1,495
0,00223	-0,254	0,1966	-0,254	-0,05	0,984	-0,050
0,00276	-0,181	0,1788	-0,181	-0,031	1,04	-0,03204
0,01762	-0,227	1,3887	-0,228	-0,045	6,914	-0,051
0,01544	0,329	8,1903	0,3208	-0,1892	-1,425	-1,893
0,01016	0,171	4,9531	0,166	-1,747	-0,487	-1,747

14

ILOVALAR:

Elementlarning nomlanishi	β_i burchak	Direksion burchak α_i	S_i tomon	Abssissa x_i	Ordinata u_i
$\left[\dfrac{EF}{p}\right]$	$\dfrac{1}{P}$	$\dfrac{i}{P}$	S_i	$\dfrac{q}{\rho}\left[(y_{i+1}-y)^2\right]_1^i + \left[S\cos^2\alpha\right]_1^i$	$\dfrac{q}{\rho}\left[(x_{i+1}-x)^2\right]_1^i + \left[S\sin^2\alpha\right]_1^i$
$\left[\dfrac{aF}{p}\right]$	$\dfrac{1}{P}$	$\dfrac{i}{P}$	0	$-q\left[(y_{i+1}-y)^2\right]_1^i$	$-q\left[(x_{i+1}-x)^2\right]_1^i$
$\left[\dfrac{bF}{p}\right]$	$q\,\eta_i$	$q\,[\eta]_1^i$	Δx_i	$-\dfrac{q}{\rho}\left[(y_{i+1}-y)\eta\right]_1^i + \left[S\cos^2\alpha\right]_1^i$	$\dfrac{q}{\rho}\left[(x_{i+1}-x)\eta\right]_1^i + \left[S\sin\alpha\cos\right.$
$\left[\dfrac{cF}{p}\right]$	$-q\,\xi_i$	$-q\,[\xi]_1^i$	Δy_i	$\dfrac{q}{\rho}\left[(y_{i+1}-y)\xi\right]_1^i + \left[S\sin\alpha\cos\alpha\right]_1^i$	$-\dfrac{q}{\rho}\left[(x_{i+1}-x)\xi\right]_1^i + \left[S\sin^2\alpha\right.$

Punktlar	$\left[\frac{\alpha F}{p}\right]$	$\left[\frac{bF}{p}\right]$	$\left[\frac{cF}{p}\right]$	$\left[-\frac{C}{A}\left[\frac{bF}{p}\right]\right]$	$\left[\left[\frac{cF}{p}\right]-\frac{C}{A}\left[\frac{bF}{p}\right]\right]$	$\left[\frac{FF}{p}\right]$	$-P\dfrac{\left[\frac{\alpha F}{p}\right]^2}{n+1}$	$\dfrac{\left[\frac{bF}{p}\right]^2}{A}$	$\dfrac{\left[\left[\frac{cF}{p}\right]-\frac{C}{A}\left[\frac{bF}{p}\right]\right]^2}{B-\frac{C^2}{A}}$		m_u
Tenglashtirilgan direksion burchaklarning aniqligini baholash.											
4	$10*10^8$	$-1*10^6$	$38*10^4$	$2*10^5$	$18*10^4$	$10*10^8$	$-8*10^8$	$1*10^8$	$-2*10^3$	$1*10^8$	±1,2
5	$13*10^8$	$-1*10^6$	$21*10^4$	$2*10^5$	$1*10^4$	$13*10^8$	$-10*10^8$	$1,2*10^8$	$-2*10^7$	$4*10^8$	±1,2
Tenglashtirilgan absissalar aniqligini baholash.											
4	$-6*10^9$	$-2*10^3$	$4*10^2$	$-3*10^2$	$7*10^2$	$28*10^3$	$27*109$	$5*10^2$	$1*10^{-1}$	$2*10^3$	±0,3
5	$-9*10^9$	$8*10^3$	$-6*10^2$	$-1*10^2$	$-5*10^2$	$44*10^3$	$-49*10^9$	$77*10^2$	$-7*10^{-2}$	$4*10^3$	±0,4
Tenglashtirilgan ordinatalar aniqligini baholash.											
4	$2*10^4$	$-4*10^2$	$2*10^3$	$7*10^1$	$19*10^2$	$2*10^3$	0,3	19	$9*10^{-3}$	$4*10^3$	±0,003
5	$10*10^4$	$-13*10^2$	$3*10^3$	$17*10^3$	$-14*10^3$	$3*10^3$	6	$8*10^3$	$7*10^{-1}$	$6*10^3$	±0,03

i	3	4
$y_{i+1}-y_1$	2361,33	2449,511
$y_{i+1}-y_2$	1880,912	1969,093
$y_{i+1}-y_3$	1159,082	1274,263
$y_{i+1}-y_4$	444,627	532,808
$y_{i+1}-y_5$	0	88,181
$\sum$	2361,33	2449,511
$x_{i+1}-x_1$	-323,315	118,171
$x_{i+1}-x_2$	-462,638	-21,152
$x_{i+1}-x_3$	-347,344	94,142
$x_{i+1}-x_4$	-188,954	252,532
$x_{i+1}-x_5$		441,486
$\sum$	-323,315	118,171
$\left[S*\cos^2\alpha\right]$	91,26	165
$\left[S*\sin\alpha*\cos\alpha\right]$	-289	637
$\left[S*\sin^2\alpha\right]$	1871	2281
$[n]$	-292	-701
$[\xi]$	239	130

$$\frac{C}{A}=0,266\,; \qquad B-\frac{C^2}{A}=5398\,.$$
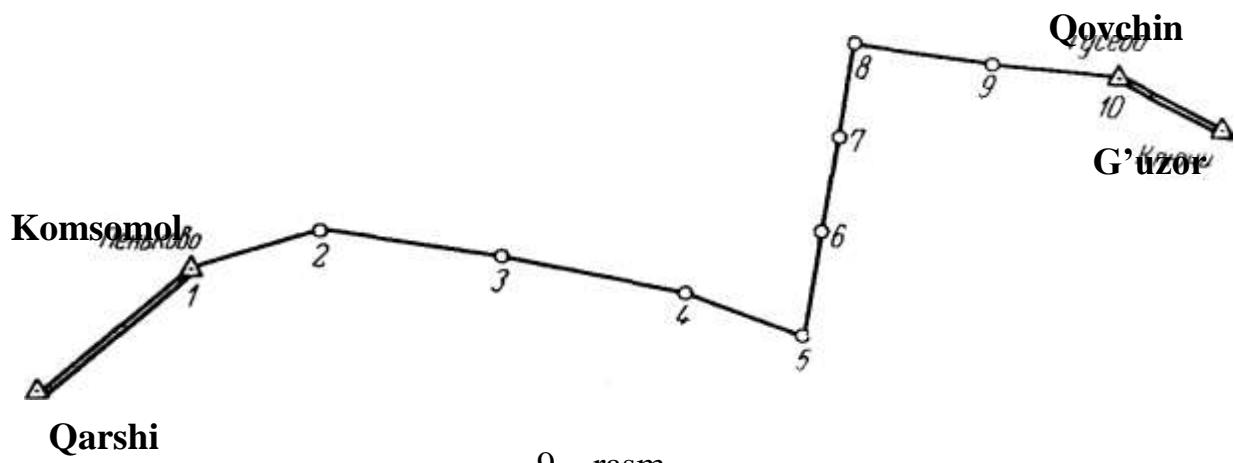
9 – rasm.

Talabalar uchun beriladigan
Kurs ishi variantlari.

9 – Jadval.

Variantlar №.	Direksion burchaklar.		Koordinatalar.			
	Qarshi – Komsomol $\alpha_б$	Qovchin – G'uzor α_0	Komsomol		Qovchin	
			X_b	y_b	X_o	y_o
1	**2**	**3**	**4**	**5**	**6**	**7**
1.	73^0 50'57"	126^0 10'45"	6385,808	4108	7155,648	7741,96
2.	76^0 10'58"	128^0 30'46"	6385,808	4108	7006,026	7742,944
3.	75^0 50'57"	127^0 30'46"	6385,808	4108	7070,482	7731,613
4.	70°10' 49"	122°30' 37"	6385,808	4108	7382,585	7658,312
5.	75^0 10'55"	127^0 30'43"	6385,808	4108	7069,406	7731,601
6.	72^0 10'56"	124^0 30'43"	6385,808	4108	7259,131	7692,848
7.	73^0 10'55"	125^0 30'43"	6385,808	4108	7195,451	7705,537
8.	75^0 30'59"	127^0 30'47"	6385,808	4108	7048,231	7735,525
9.	75^0 30'56"	127^0 50'44"	6385,808	4108	7141,047	7662,764
10.	76^0 30'39"	120^0 50'47"	6385,808	4108	7058,759	7663,280
11.	83^0 10'55"	132^0 30'43"	6385,808	4108	6558,808	7791,339
12.	73^0 10'58"	125^0 30'46"	6385,808	4108	7195,362	7705,452
13.	76^0 30'51"	128^0 50'47"	6385,808	4108	7336,854	7771,239
14	78^0 30'56"	126^0 50'47"	6385,808	4108	6846,72	8042,35
15.	80^0 10'58"	132^0 30'46"	6385,808	4108	6750,940	7777,404
16.	72^0 50'57"	125^0 10'41"	6385,808	4108	7277,236	7674,873
17.	75^0 50'57"	128^0 10'45"	6385,808	4108	7027,153	7739,327
18.	79^0 30'59"	130^0 50'47"	6385,808	4108	6811,070	7776,846
19.	73^0 50'57"	126^0 10'45"	6385,808	4108	7155,648	7741,26
20.	76^0 10'55"	128^0 30'43"	6385,808	4108	7006,228	7742,987
21.	80^0 10'58"	132^0 30'46"	6385,808	4108	6750,940	7777,404
22.	82^0 50'57"	135^0 10'31"	6385,808	4108	6580,0492	7781,613
23.	82^0 10'58"	134^0 30'48"	6385,808	4108	6253,8862	7923,1646
24.	78^0 10'55"	130^0 30'43"	6385,808	4108	6630,4282	7836,1346

25.	80⁰ 10'55"	132⁰ 30'45"	6385,808	4108	6751,014	7777,376
26.	83⁰ 50'57"	136⁰ 10'47"	6385,808	4108	6515,520	7793,230
27.	80⁰ 10'58"	132⁰ 30'46"	6385,808	4108	6750,940	7777,404
28.	81⁰ 30'56"	133⁰ 50'46"	6385,808	4108	6295,742	7913,4946
29.	77⁰ 30'59"	129⁰ 50'47"	6385,808	4108	6755,9422	7807,1246
30.	77⁰ 51'57"	130⁰ 10'45"	6385,808	4108	6898,811	7776,377
31.	76⁰ 50'57"	129⁰ 10'47"	6385,808	4108	6963,699	7749,983
32.	83⁰ 10'55"	135⁰ 30'43"	6385,808	4108	6565,501	7790,57
33.	80⁰ 30'59"	132⁰ 50'47"	6385,808	4108	6729,680	7779,4196
34.	80⁰ 30'56"	132⁰ 50'44"	6385,808	4108	6618,83	7600,906
35.	79⁰ 30'59"	130⁰ 50'47"	6385,808	4108	6811,070	7776,846
36.	79⁰ 50'57"	132⁰ 10'45"	6385,808	4108	6772,308	7775,204
37.	79⁰ 30'56"	131⁰ 50'44"	6385,808	4108	6504,9142	7865,1446
38.	81⁰ 30'59"	133⁰ 50'47"	6385,808	4108	6996,8682	7827,37
39.	83⁰ 30'50"	135⁰ 50'44"	6385,808	4108	6519,990	7786,398
40.	84⁰ 30'56"	136⁰ 50'44"	6385,808	4108	6472,608	7794,4
41.	81⁰ 10'58"	132⁰ 30'39"	6385,808	4108	6894,940	7782,10
42.	83⁰ 10'55"	135⁰ 30'29"	6385,808	4108	6558,468	7791,442
43.	82⁰ 50'57"	135⁰ 10'31"	6385,808	4108	6580,0492	7781,613
44.	86⁰ 30'56"	137⁰ 50'20"	6385,808	4108	6455,46	7807,105
45.	86⁰ 10'58"	138⁰ 30'32"	6385,808	4108	6365,398	7795,3844
46.	85⁰ 32'57"	137⁰ 52'31"	6385,808	4108	6406,208	7788,15
47.	82⁰ 50'57"	135⁰ 10'31"	6385,808	4108	6580,0492	7781,613
48.	82⁰ 10'58"	134⁰ 30'39"	6385,808	4108	6894,95	7782,10
49.	84⁰ 30'56"	136⁰ 50'44"	6385,808	4108	6472,608	7794,400
50.	82⁰ 10'55"	134⁰ 30'43"	6385,808	4108	6622,8	7672,3934
51.	83⁰ 30'56"	135⁰ 50'46"	6385,808	4108	6449,808	7792,4
52.	83⁰ 10'55"	132⁰ 30'43"	6385,808	4108	6558,808	7791,339
53.	80⁰ 10'55"	135⁰ 30'29"	6385,808	4108	6558,468	7791,442
54.	83⁰30' 56"	135⁰ 50' 44"	6385,808	4108	6520,119	7786,398
55.	85⁰32' 57"	137⁰ 52' 31"	6385,808	4108	6408,208	7788,15
56.	73°30' 59"	125°50' 47"	6385,808	4108	7174,295	7710,303
57.	73°10' 58"	125°30' 46"	6385,808	4108	7195,255	7705,649
58.	72°50' 57"	125°10' 45"	6385,808	4108	7216,186	7700,878
59.	72°30' 56",	124°50' 44"	6385,808	4108	7237,095	7695,981
60.	72°10' 55"	124°30' 43"	6385,808	4108	7257,970	7690,962
61.	71°50' 54"	124°10' 42"	6385,808	4108	7278,816	7685,825
62.	71°30' 53"	123°50' 41"	6385,808	4108	7299,636	7680,563
63.	71°10' 52"	123°30' 40"	6385,808	4108	7320,423	7675,183
64.	70°50' 51"	123°10' 39"	6385,808	4108	7341,173	7669,677
65.	70°10' 49"	122°30' 37"	6385,808	4108	7382,585	7658,312
66.	82⁰ 10'55"	134⁰ 30'43"	6385,808	4108	6622,8	7672,3934
67.	81⁰ 30'56"	133⁰ 50'46"	6385,808	4108	6295,742	7913,4946
68.	77⁰ 30'59"	129⁰ 50'47"	6385,808	4108	6755,9422	7807,1246
69.	77⁰ 51'57"	130⁰ 10'45"	6385,808	4108	6898,811	7776,377
70.	76⁰ 50'57"	129⁰ 10'47"	6385,808	4108	6963,699	7749,983

71.	83^0 10'55"	135^0 30'43"	6385,808	4108	6565,501	7790,57
72.	72^0 10'56"	124^0 30'43"	6385,808	4108	7259,131	7692,848
73.	73^0 10'55"	125^0 30'43"	6385,808	4108	7195,451	7705,537
74.	75^0 30'59"	127^0 30'47"	6385,808	4108	7048,231	7735,525
75.	75^0 30'56"	127^0 50'44"	6385,808	4108	7141,047	7662,764
76.	76^0 30'39"	120^0 50'47"	6385,808	4108	7058,759	7663,280
77.	78^0 10'55"	130^0 30'43"	6385,808	4108	6630,4282	7836,1346
78.	81^0 30'59"	133^0 50'47"	6385,808	4108	6996,8682	7827,37
79.	83^0 30'50"	135^0 50'44"	6385,808	4108	6519,990	7786,398
80.	84^0 30'56"	136^0 50'44"	6385,808	4108	6472,608	7794,4
81.	86^0 10'58"	138^0 30'32"	6385,808	4108	6365,398	7795,3844
82.	85^0 32'57"	137^0 52'31"	6385,808	4108	6406,208	7788,15
83.	82^0 50'57"	135^0 10'31"	6385,808	4108	6580,0492	7781,613
84.	82^0 10'58"	134^0 30'48"	6385,808	4108	6253,8862	7923,1646
85.	71°30' 53"	123°50' 41"	6385,808	4108	7299,636	7680,563
86.	72°10' 55"	124°30' 43"	6385,808	4108	7257,970	7690,962

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