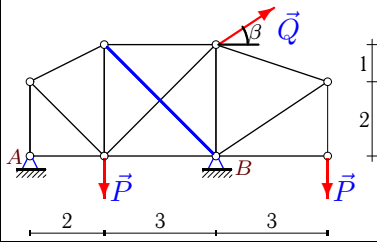


## Расчет статически неопределимой фермы (2)

Найти реакции опор фермы и усилие  $S$  в дополнительном раскосе, выделенном утолщенной линией.

**Задача 24.1.**

2



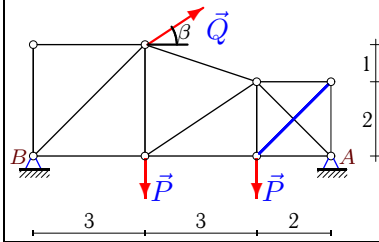
$$P = 12 \text{ кН},$$

$$Q = 7 \text{ кН},$$

$$\beta = 45^\circ.$$

**Задача 24.2.**

2



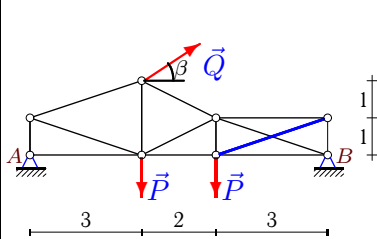
$$P = 6 \text{ кН},$$

$$Q = 7 \text{ кН},$$

$$\beta = 45^\circ.$$

**Задача 24.3.**

2



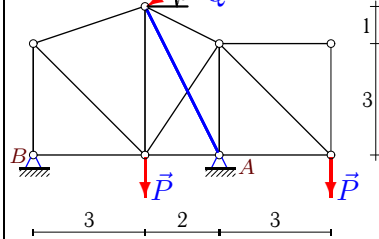
$$P = 11 \text{ кН},$$

$$Q = 9 \text{ кН},$$

$$\beta = 45^\circ.$$

**Задача 24.4.**

2



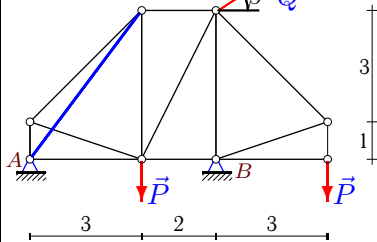
$$P = 9 \text{ кН},$$

$$Q = 3 \text{ кН},$$

$$\beta = 30^\circ.$$

**Задача 24.5.**

2



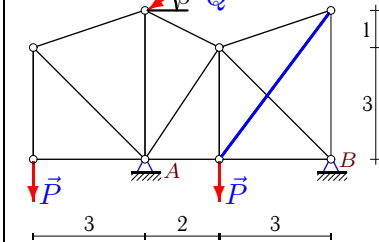
$$P = 6 \text{ кН},$$

$$Q = 7 \text{ кН},$$

$$\beta = 15^\circ.$$

**Задача 24.6.**

2



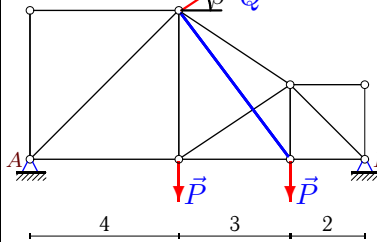
$$P = 9 \text{ кН},$$

$$Q = 9 \text{ кН},$$

$$\beta = 30^\circ.$$

**Задача 24.7.**

2



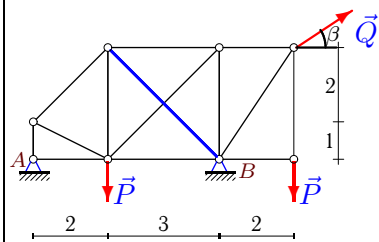
$$P = 7 \text{ кН},$$

$$Q = 6 \text{ кН},$$

$$\beta = 15^\circ.$$

**Задача 24.8.**

2



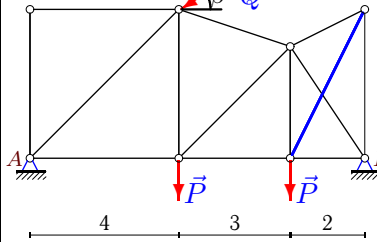
$$P = 12 \text{ кН},$$

$$Q = 8 \text{ кН},$$

$$\beta = 30^\circ.$$

**Задача 24.9.**

2



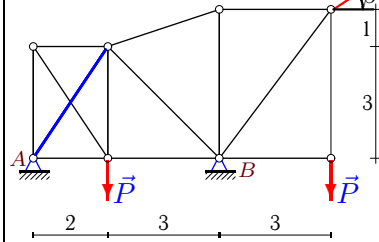
$$P = 12 \text{ кН},$$

$$Q = 6 \text{ кН},$$

$$\beta = 30^\circ.$$

**Задача 24.10.**

2



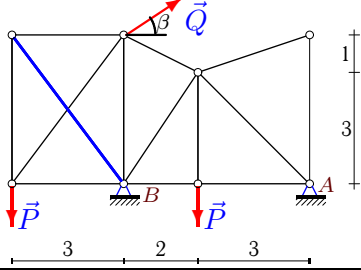
$$P = 11 \text{ кН},$$

$$Q = 5 \text{ кН},$$

$$\beta = 15^\circ.$$

**Задача 24.11.**

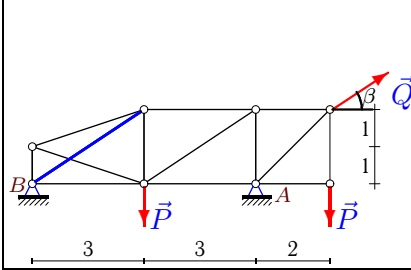
2



$P = 12 \text{ кН},$   
 $Q = 6 \text{ кН},$   
 $\beta = 30^\circ.$

**Задача 24.12.**

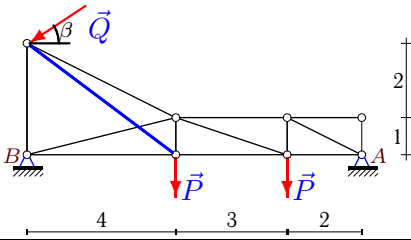
2



$P = 11 \text{ кН},$   
 $Q = 8 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.13.**

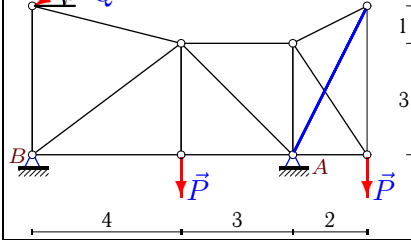
2



$P = 6 \text{ кН},$   
 $Q = 8 \text{ кН},$   
 $\beta = 15^\circ.$

**Задача 24.14.**

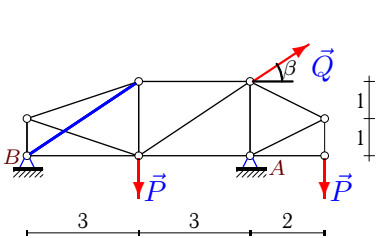
2



$P = 10 \text{ кН},$   
 $Q = 3 \text{ кН},$   
 $\beta = 15^\circ.$

**Задача 24.15.**

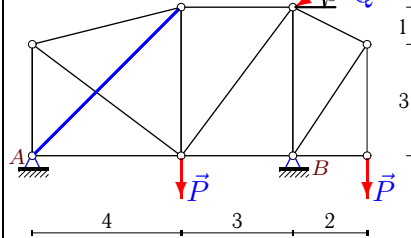
2



$P = 11 \text{ кН},$   
 $Q = 9 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.16.**

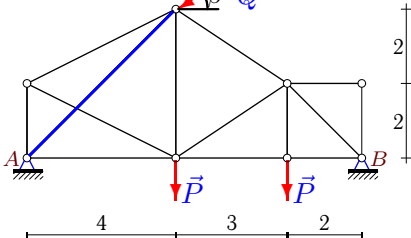
2



$P = 12 \text{ кН},$   
 $Q = 4 \text{ кН},$   
 $\beta = 30^\circ.$

**Задача 24.17.**

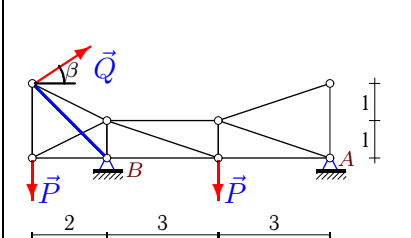
2



$P = 9 \text{ кН},$   
 $Q = 8 \text{ кН},$   
 $\beta = 30^\circ.$

**Задача 24.18.**

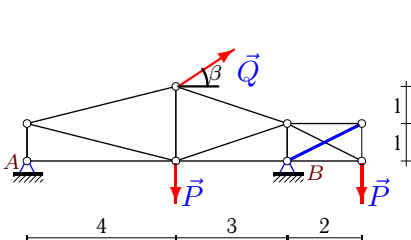
2



$P = 12 \text{ кН},$   
 $Q = 7 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.19.**

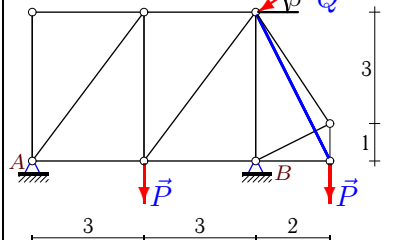
2



$P = 12 \text{ кН},$   
 $Q = 8 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.20.**

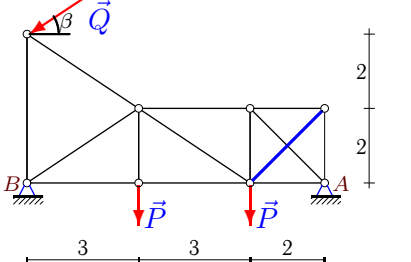
2



$P = 13 \text{ кН},$   
 $Q = 7 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.21.**

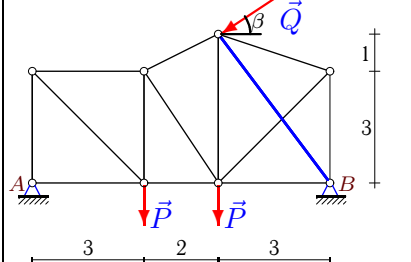
2



$P = 6 \text{ кН},$   
 $Q = 5 \text{ кН},$   
 $\beta = 30^\circ.$

**Задача 24.22.**

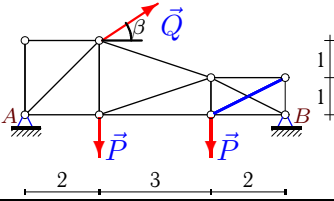
2



$P = 13 \text{ кН},$   
 $Q = 4 \text{ кН},$   
 $\beta = 15^\circ.$

**Задача 24.23.**

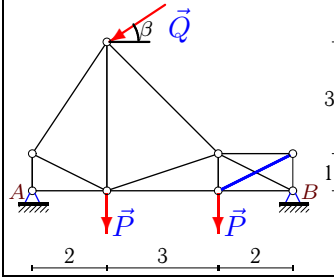
2



$P = 11 \text{ кН},$   
 $Q = 6 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.24.**

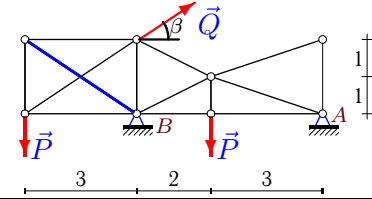
2



$P = 12 \text{ кН},$   
 $Q = 3 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.25.**

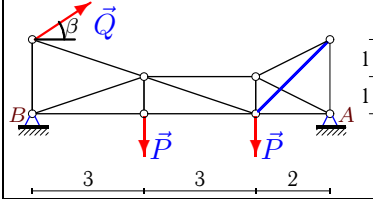
2



$P = 13 \text{ кН},$   
 $Q = 8 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.26.**

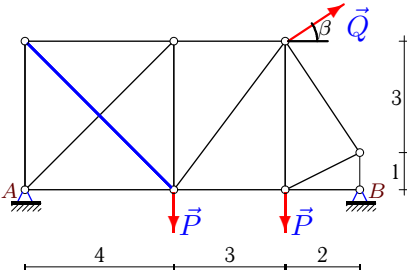
2



$P = 9 \text{ кН},$   
 $Q = 8 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.27.**

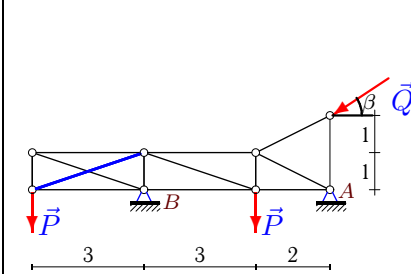
2



$P = 7 \text{ кН},$   
 $Q = 4 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.28.**

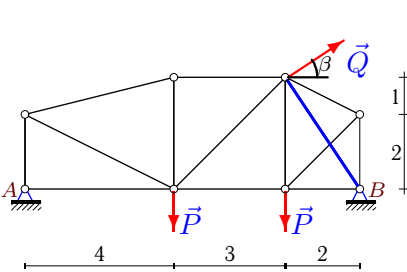
2



$P = 6 \text{ кН},$   
 $Q = 3 \text{ кН},$   
 $\beta = 45^\circ.$

**Задача 24.29.**

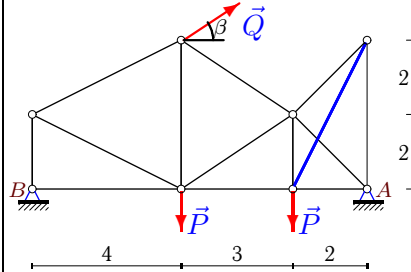
2



$P = 7 \text{ кН},$   
 $Q = 3 \text{ кН},$   
 $\beta = 15^\circ.$

**Задача 24.30.**

2



$P = 6 \text{ кН},$   
 $Q = 9 \text{ кН},$   
 $\beta = 15^\circ.$

**Расчет статически неопределимой фермы (2)**

	$\delta_{11}$	$\delta_{12}$	$\delta_{22}$	$\Delta_{1p}$	$\Delta_{2p}$	$X_B$	$S$	$X_A$	$Y_A$	$Y_B$
1	5.000	-2.121	10.243	-26.101	142.916	-0.767	-14.112	-4.183	-2.970	22.020
2	8.000	1.414	6.828	-9.902	-38.031	0.263	5.515	-5.213	6.750	0.300
3	8.000	-2.846	8.762	172.159	-192.651	-15.488	16.956	9.124	5.432	10.205
4	5.000	0.894	7.503	12.804	96.308	-0.270	-12.804	2.868	18.622	0.878
5	5.000	-1.800	6.200	11.284	-49.179	0.669	8.127	-7.430	-6.609	16.797
6	5.000	-1.800	8.760	-40.177	33.773	7.178	-2.380	0.616	30.535	-8.035
7	9.000	-1.800	6.750	83.412	-27.880	-8.917	1.752	3.122	2.006	10.441
8	5.000	-2.121	10.243	-2.144	110.044	-4.527	-11.681	-2.401	-0.157	20.157
9	9.000	-0.894	7.503	78.088	-88.193	-7.598	10.849	12.794	13.309	13.691
10	5.000	-1.109	8.990	17.974	-63.890	-2.075	6.851	-2.755	-3.087	23.793
11	5.000	0.000	12.280	17.196	126.086	-3.439	-10.268	-1.757	1.757	19.243
12	6.000	2.496	7.404	33.000	16.588	-5.313	-0.449	-0.344	14.510	1.833
13	9.000	3.200	9.421	-129.090	-125.211	10.939	9.575	-3.212	4.758	9.313
14	7.000	-0.000	7.503	-22.027	67.732	3.147	-9.028	-0.249	16.916	3.861
15	6.000	2.496	7.404	52.092	-2.606	-10.269	3.814	3.905	15.924	-0.288
16	7.000	-2.828	10.722	-31.856	47.522	3.089	-3.617	0.375	3.694	22.306
17	9.000	-2.828	9.090	20.780	126.137	-7.393	-16.176	14.321	12.301	9.699
18	6.000	0.000	4.545	-5.397	45.283	0.899	-9.963	-5.849	5.300	13.750
19	7.000	0.000	5.836	-49.373	112.176	7.053	-19.221	-12.710	-2.326	20.669
20	6.000	-0.000	4.303	-22.050	-33.930	3.675	7.886	1.275	5.466	25.483
21	8.000	1.414	6.828	-58.585	-37.432	6.596	4.116	-2.265	4.585	9.915
22	8.000	-1.800	8.760	11.322	71.648	-3.413	-8.881	7.277	15.320	11.715
23	7.000	-1.789	5.836	132.000	-99.274	-15.743	12.185	11.501	6.757	11.000
24	7.000	-1.789	5.836	109.696	-103.100	-12.105	13.956	14.226	14.727	11.394
25	5.000	-0.000	8.990	33.343	149.000	-6.669	-16.574	1.012	-0.337	20.680
26	8.000	1.414	4.545	-185.078	-78.410	21.254	10.638	-26.911	11.539	0.804
27	9.000	-2.828	13.657	36.968	-56.602	-3.000	3.523	0.172	3.559	7.613
28	5.000	0.000	8.762	48.909	-110.961	-9.782	12.663	11.903	1.273	12.849
29	9.000	-1.109	5.524	29.426	40.956	-4.290	-8.276	1.392	4.306	8.918
30	9.000	0.894	5.063	-7.342	-37.754	0.076	7.444	-8.769	10.162	-0.491

В первой строке — усилия от действия основной нагрузки, во второй — от единичной горизонтальной силы в опоре В, в третьей — от единичных сил в дополнительном раскосе.

	$U_1$	$U_2$	$U_3$	$V_1$	$V_2$	$V_3$	$V_4$	$O_1$	$O_2$	$O_3$	$D_1$	$D_2$	$D_3$
1	4.950	-12.000	-0.000	2.970	-0.990	-14.020	12.000	2.214	1.980	12.649	-2.800	21.171	-14.422
	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	-0.707	0.000	0.000	-0.707	-0.707	0.000	0.000	-0.707	0.000	0.000	1.000	-0.000
2	0.300	1.800	1.800	0.000	7.000	6.000	-0.000	0.000	-5.534	0.000	-0.425	-1.803	-9.546
	-1.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.707	0.000	0.000	-0.707	0.000	0.000	0.000	-0.707	0.000	0.000	1.000
3	6.364	30.614	30.614	-5.432	16.335	11.000	-0.000	-8.588	-16.224	0.000	8.588	-18.003	-32.269
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.949	-0.000	0.000	-0.316	-0.316	0.000	0.000	-0.949	0.000	0.000	1.000
4	0.000	-6.402	-9.000	-0.878	-2.250	-18.622	0.000	-0.694	2.168	0.000	0.932	12.729	12.728
	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	-0.447	-0.000	0.000	-0.671	-0.894	0.000	0.000	-0.500	0.000	-0.000	0.806	0.000
5	6.761	-4.500	-0.000	6.609	-4.957	-15.297	6.000	7.010	4.957	6.364	-5.225	14.097	-4.743
	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.600	0.000	0.000	-0.800	-0.200	0.000	0.000	-0.849	0.000	0.000	0.632	-0.000	0.000
6	0.000	-8.035	-8.035	9.000	-14.022	9.000	0.000	7.115	16.261	-0.000	-9.546	-11.734	11.364
	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	-0.000	-0.600	0.000	-0.000	-0.800	-0.600	0.000	0.000	-0.632	-0.000	0.000	0.849
7	7.801	10.441	10.441	0.000	8.760	7.000	0.000	0.000	-9.376	0.000	-2.837	-3.173	-14.766
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	-0.600	0.000	-0.000	-0.400	-0.800	0.000	0.000	-0.721	0.000	0.000	0.721	0.000
8	6.928	-5.333	0.000	0.157	-0.105	-12.157	12.000	0.148	0.105	12.262	-0.117	17.192	-9.615
	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	-0.707	0.000	0.000	-0.707	-0.707	0.000	0.000	-0.707	0.000	0.000	1.000	0.000
9	8.113	9.127	9.127	0.000	13.014	12.000	0.000	0.000	-8.552	0.000	-18.822	-1.434	-16.454
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.447	-0.000	0.000	-0.894	-0.671	0.000	0.000	-0.500	0.000	0.000	0.806
10	4.830	2.771	0.000	3.087	14.087	-4.036	11.000	2.058	12.764	12.109	-3.710	-14.214	-12.132
	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.555	0.000	0.000	-0.832	-0.832	0.000	0.000	-0.555	0.000	0.000	1.000	0.000	0.000
11	-9.000	-3.439	-3.439	-0.000	-10.902	12.000	-0.000	0.000	4.253	0.000	15.000	-10.025	-2.485
	0.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.600	0.000	0.000	-0.800	-0.800	0.000	-0.000	-0.600	0.000	0.000	1.000	-0.000	0.000
12	0.000	-11.000	0.000	-1.833	0.917	-9.167	11.000	-2.899	-2.750	11.000	2.899	16.525	-7.556
	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.832	-0.000	-0.000	-0.555	-0.277	0.000	0.000	-0.877	0.000	0.000	0.877	-0.000	0.000
13	13.515	13.515	17.242	-5.934	6.000	4.758	0.000	8.640	-9.515	0.000	-13.931	3.929	-10.638
	-1.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.800	0.000	0.000	-0.200	-0.600	-0.000	0.000	-0.894	0.000	0.000	0.825	0.000	0.000
14	3.147	3.147	-6.667	-1.501	10.000	-10.000	0.000	2.987	6.667	0.000	-3.933	-9.780	12.019
	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.447	0.000	0.000	-0.894	-0.671	0.000	-0.000	-0.500	-0.000	0.000	0.806
15	0.000	-17.364	-0.000	0.288	-0.144	-10.424	11.000	0.455	0.432	12.298	-0.455	20.350	-12.298
	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.832	-0.000	-0.000	-0.555	-0.277	0.000	0.000	-0.877	0.000	0.000	0.877	-0.000	0.000
16	-3.464	-6.000	0.000	-3.694	0.923	-13.306	12.000	-3.807	-3.694	6.708	4.617	10.383	-10.817
	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.707	0.000	0.000	-0.707	-0.530	0.000	0.000	-0.729	0.000	0.000	0.884	0.000	0.000
17	-6.928	9.699	9.699	-12.301	5.733	9.000	-0.000	-13.753	-6.458	-0.000	13.753	-5.198	-13.716
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.707	0.000	0.000	-0.707	-0.354	0.000	0.000	-0.791	0.000	0.000	0.791	-0.000	0.000
18	-9.151	-9.151	10.950	7.425	-13.750	5.300	-0.000	-5.534	-15.899	-0.000	10.231	21.188	-16.760
	0.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.707	0.000	0.000	-0.354	-0.707	0.000	-0.000	-0.791	0.000	0.000	0.791	-0.000	0.000
19	5.657	-24.000	-24.000	2.326	4.828	-20.669	-0.000	4.796	-1.059	-0.000	-4.796	26.357	26.833
	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.894	0.000	0.000	-0.447	-0.447	0.000	0.000	-0.894	0.000	0.000	1.000
20	-0.850	-6.500	0.000	-0.000	5.466	-22.233	13.000	0.000	-4.100	11.718	-6.833	9.417	-7.267
	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.000	-0.000	-0.447	0.000	-0.000	-0.224	-0.894	0.000	0.000	-0.806	0.000	0.000	0.500
21	6.792	6.792	8.915	-5.387	6.000	4.585	0.000	5.204	-4.585	-0.000	-8.164	2.551	-6.484
	-1.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.707	0.000	0.000	-0.707	0.000	0.000	0.000	-0.707	0.000	0.000	1.000
22	-3.864	11.456	0.000	-15.320	-2.320	8.219	-11.715	-15.320	-14.143	-9.262	21.666	-4.813	12.426
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.600	0.000	0.000	-0.600	-0.800	0.000	-0.000	-0.632	0.000	0.000	0.849
23	11.000	22.000	22.000	-0.000	14.667	11.000	-0.000	0.000	-11.595	0.000	-9.556	-11.595	-24.597
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.894	0.000	0.000	-0.447	-0.447	0.000	0.000	-0.894	0.000	0.000	1.000
24	-2.121	22.788	22.788	-14.727	14.167	12.000	0.000	-13.275	-7.414	0.000	8.233	-18.495	-25.478
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.894	-0.000	-0.000	-0.447	-0.447	-0.000	-0.000	-0.894	0.000	0.000	1.000
25	-19.500	-6.669	-6.669	0.000	-14.265	13.000	-0.000	0.000	15.477	0.000	23.436	-14.346	1.067
	0.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.832	0.000	0.000	-0.555	-0.555	0.000	0.000	-0.832	-0.000	-0.000	1.000	-0.000	-0.000
26	25.039	25.039	17.422	7.542	9.000	11.539	0.000	-5.963	-23.078	-0.000	-26.394	-8.030	-25.802
	-1.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	-0.707	0.000	0.000	-0.707	-0.354	0.000	0.000	-0.791	0.000	0.000	0.791
27	6.387	3.806	0.000	0.000	3.559	5.097	-7.613	0.000	-3.559	-6.862	-5.033	4.301	4.256
	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.707	0.000	0.000	-0.707	-0.707	0.000	0.000	-0.707	0.000	0.000	1.000	0.000	0.000
28	0.000	-18.000	2.546	6.000	-6.849	-0.849	-1.061	18.000	-2.546	-2.372	-18.974	21.657	-0.474
	0.000	-1.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-0.949	-0.000	-0.000	-0.316	-0.316	-0.000	-0.949	0.000	0.000	0.000	1.000	0.000	0.000
29	2.898	5.945	-0.000	-4.306	1.435	1.055	-8.918	-5.918	-5.741	-6.647	6.419	3.810	8.408
	1.000	1.000	1.000	0.000	0.000	0.000	0.000						