

## Равновесие тяжелой рамы

Тяжелая однородная рама расположена в вертикальной плоскости и опирается на неподвижный шарнир  $A$  и наклонный невесомый стержень  $H$ . К раме приложены горизонтальная сила  $P$ , наклонная сила  $Q$  и момент  $M$ . Учитывая погонный вес рамы  $\rho$ , найти реакции опор.

*Кирсанов М.Н. Решебник. Теоретическая механика с. 31.*

**Вариант 1**  
С4.

$\rho = 3 \text{ кН/м}, P = 7 \text{ кН},$   
 $Q = 29 \text{ кН}, M = 25 \text{ кНм},$   
 $\alpha = 60^\circ, \beta = 30^\circ, \gamma = 60^\circ,$   
 $HB = 3 \text{ м}, BC = 4 \text{ м},$   
 $CD = 10 \text{ м}, DA = 6 \text{ м},$   
 $CK = 2 \text{ м}, CN = 2 \text{ м}.$

**Вариант 2**  
С4.

$\rho = 1 \text{ кН/м}, P = 6 \text{ кН},$   
 $Q = 14 \text{ кН}, M = 30 \text{ кНм},$   
 $\alpha = 60^\circ, \beta = 45^\circ, \gamma = 30^\circ,$   
 $AB = 4 \text{ м}, BC = 6 \text{ м},$   
 $CD = 9 \text{ м}, DH = 4 \text{ м},$   
 $CK = 2 \text{ м}, CN = 3 \text{ м}.$

**Вариант 3**  
С4.

$\rho = 2 \text{ кН/м}, P = 8 \text{ кН},$   
 $Q = 15 \text{ кН}, M = 50 \text{ кНм},$   
 $\alpha = 60^\circ, \beta = 60^\circ, \gamma = 45^\circ,$   
 $AB = 4 \text{ м}, BC = 10 \text{ м},$   
 $CD = 7 \text{ м}, DH = 4 \text{ м},$   
 $BK = 2 \text{ м}, CN = 3 \text{ м}.$

**Вариант 4**  
С4.

$\rho = 3 \text{ кН/м}, P = 7 \text{ кН},$   
 $Q = 12 \text{ кН}, M = 70 \text{ кНм},$   
 $\alpha = 60^\circ, \beta = 30^\circ, \gamma = 60^\circ,$   
 $HB = 4 \text{ м}, BC = 6 \text{ м},$   
 $CD = 9 \text{ м}, DA = 4 \text{ м},$   
 $CK = 2 \text{ м}, CN = 3 \text{ м}.$

**Вариант 5**  
С4.

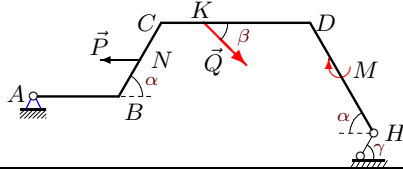
$\rho = 1 \text{ кН/м}, P = 5 \text{ кН},$   
 $Q = 34 \text{ кН}, M = 15 \text{ кНм},$   
 $\alpha = 60^\circ, \beta = 30^\circ, \gamma = 30^\circ,$   
 $AB = 4 \text{ м}, BC = 4 \text{ м},$   
 $CD = 10 \text{ м}, DH = 4 \text{ м},$   
 $CK = 2 \text{ м}, CN = 2 \text{ м}.$

**Вариант 6**  
С4.

$\rho = 3 \text{ кН/м}, P = 8 \text{ кН},$   
 $Q = 27 \text{ кН}, M = 25 \text{ кНм},$   
 $\alpha = 60^\circ, \beta = 45^\circ, \gamma = 60^\circ,$   
 $HB = 6 \text{ м}, BC = 10 \text{ м},$   
 $CD = 6 \text{ м}, DA = 3 \text{ м},$   
 $BK = 2 \text{ м}, CN = 3 \text{ м}.$

**Вариант 7**

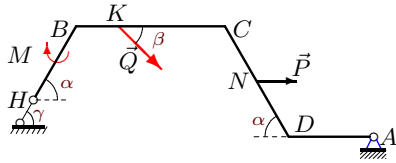
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 23 \text{ кН}$ ,  $M = 20 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  
 $CD = 7 \text{ м}$ ,  $DH = 6 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 8**

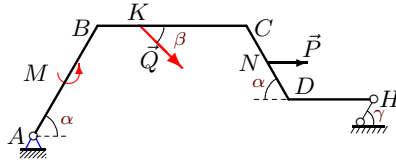
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 25 \text{ кН}$ ,  $M = 25 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 4 \text{ м}$ ,  $BC = 7 \text{ м}$ ,  
 $CD = 6 \text{ м}$ ,  $DA = 4 \text{ м}$ ,  
 $BK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 9**

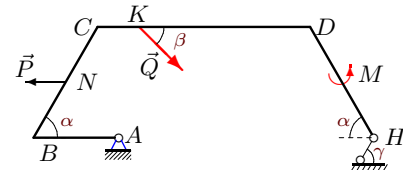
C4.



$\rho = 1 \text{ кН/м}$ ,  $P = 5 \text{ кН}$ ,  
 $Q = 19 \text{ кН}$ ,  $M = 30 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 7 \text{ м}$ ,  
 $CD = 4 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $BK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 10**

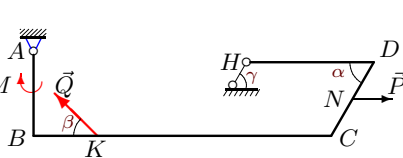
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 17 \text{ кН}$ ,  $M = 50 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  
 $CD = 10 \text{ м}$ ,  $DH = 6 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 11**

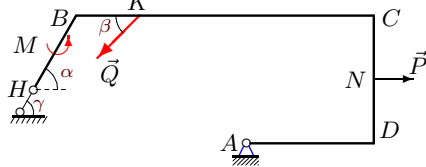
C4.



$\rho = 1 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  
 $Q = 34 \text{ кН}$ ,  $M = 15 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  
 $CD = 4 \text{ м}$ ,  $DH = 6 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 12**

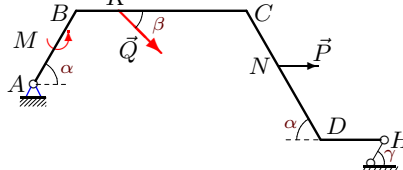
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  
 $Q = 13 \text{ кН}$ ,  $M = 70 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 4 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  
 $CD = 6 \text{ м}$ ,  $DA = 6 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 13**

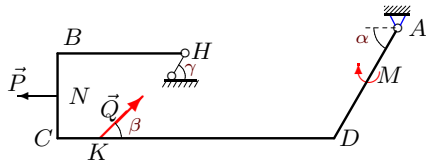
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 20 \text{ кН}$ ,  $M = 50 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 8 \text{ м}$ ,  
 $CD = 7 \text{ м}$ ,  $DH = 3 \text{ м}$ ,  
 $BK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 14**

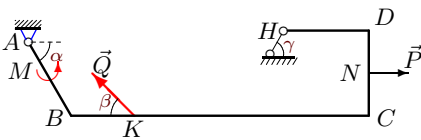
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  
 $Q = 30 \text{ кН}$ ,  $M = 25 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 6 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  
 $CD = 13 \text{ м}$ ,  $DA = 6 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 15**

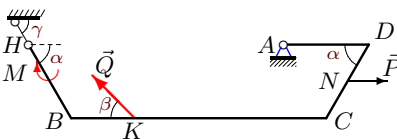
C4.



$\rho = 1 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  
 $Q = 15 \text{ кН}$ ,  $M = 30 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  
 $CD = 4 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 16**

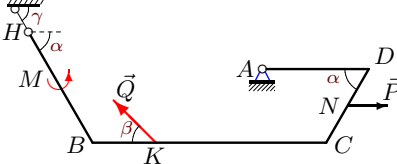
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 24 \text{ кН}$ ,  $M = 25 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 4 \text{ м}$ ,  $BC = 12 \text{ м}$ ,  
 $CD = 4 \text{ м}$ ,  $DA = 4 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 17**

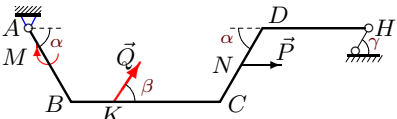
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 19 \text{ кН}$ ,  $M = 70 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 6 \text{ м}$ ,  $BC = 11 \text{ м}$ ,  
 $CD = 4 \text{ м}$ ,  $DA = 5 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 18**

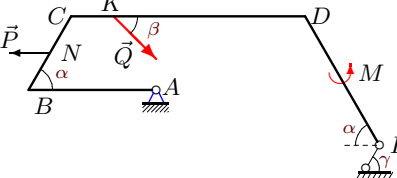
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  
 $Q = 23 \text{ кН}$ ,  $M = 20 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 7 \text{ м}$ ,  
 $CD = 4 \text{ м}$ ,  $DH = 5 \text{ м}$ ,  
 $BK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 19**

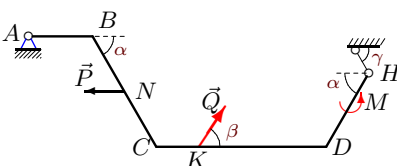
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 18 \text{ кН}$ ,  $M = 50 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  
 $CD = 11 \text{ м}$ ,  $DH = 7 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 20**

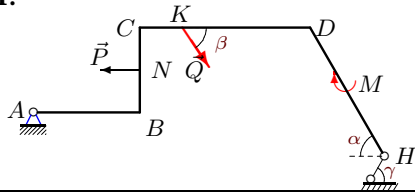
C4.



$\rho = 1 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 21 \text{ кН}$ ,  $M = 30 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 3 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  
 $CD = 8 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 21**

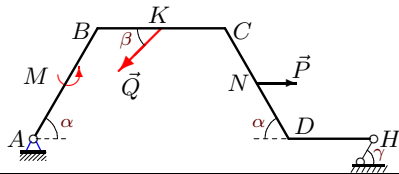
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  
 $Q = 27 \text{ кН}$ ,  $M = 20 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 5 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  
 $CD = 8 \text{ м}$ ,  $DH = 7 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 22**

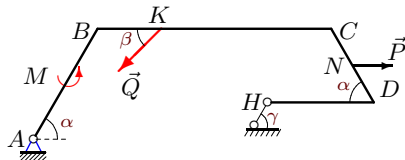
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  
 $Q = 21 \text{ кН}$ ,  $M = 50 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  
 $CD = 6 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 23**

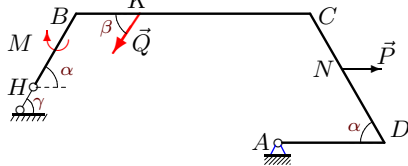
C4.



$\rho = 1 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  
 $Q = 19 \text{ кН}$ ,  $M = 30 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 11 \text{ м}$ ,  
 $CD = 4 \text{ м}$ ,  $DH = 5 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 24**

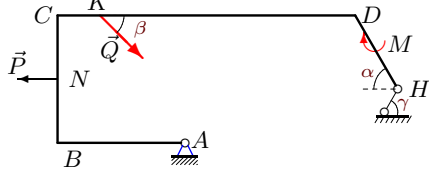
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 9 \text{ кН}$ ,  
 $Q = 26 \text{ кН}$ ,  $M = 25 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 4 \text{ м}$ ,  $BC = 11 \text{ м}$ ,  
 $CD = 7 \text{ м}$ ,  $DA = 5 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 25**

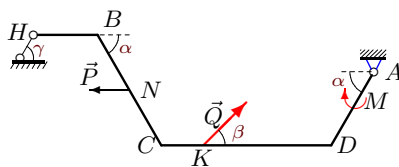
C4.



$\rho = 1 \text{ кН/м}$ ,  $P = 5 \text{ кН}$ ,  
 $Q = 35 \text{ кН}$ ,  $M = 15 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  
 $CD = 14 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 26**

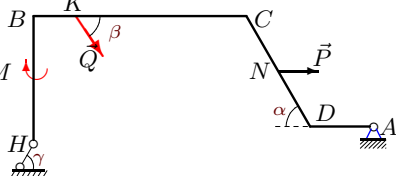
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  
 $Q = 24 \text{ кН}$ ,  $M = 25 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 3 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  
 $CD = 8 \text{ м}$ ,  $DA = 4 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 27**

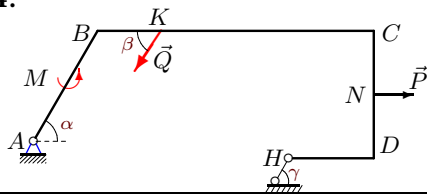
C4.



$\rho = 3 \text{ кН/м}$ ,  $P = 9 \text{ кН}$ ,  
 $Q = 31 \text{ кН}$ ,  $M = 25 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 6 \text{ м}$ ,  $BC = 10 \text{ м}$ ,  
 $CD = 6 \text{ м}$ ,  $DA = 3 \text{ м}$ ,  
 $BK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 28**

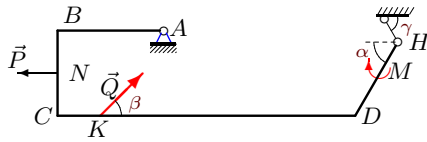
C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  
 $Q = 13 \text{ кН}$ ,  $M = 50 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 13 \text{ м}$ ,  
 $CD = 6 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Вариант 29**

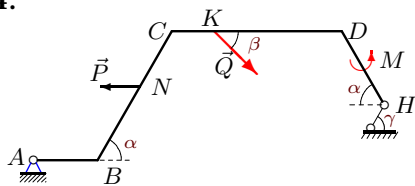
C4.



$\rho = 1 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  
 $Q = 31 \text{ кН}$ ,  $M = 15 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 5 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  
 $CD = 14 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Вариант 30**

C4.



$\rho = 2 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  
 $Q = 17 \text{ кН}$ ,  $M = 50 \text{ кНм}$ ,  
 $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 3 \text{ м}$ ,  $BC = 7 \text{ м}$ ,  
 $CD = 8 \text{ м}$ ,  $DH = 4 \text{ м}$ ,  
 $CK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

Ответы

	$M_A(Q)$	$M_A(P)$	$\Sigma_k M_A(G_k)$	$h$	$X_A$	$Y_A$	$R_H$
1	-29.000	-22.373	553.5	-13.258	-36.108	23.334	35.987
2	140.535	-15.588	-208.5	6.964	2.760	9.256	7.690
3	-77.942	-3.713	-428.0	13.814	-39.029	39.462	33.275
4	-0.431	-9.813	478.5	-14.454	-22.011	30.751	37.238
5	219.779	-10.000	-174.0	7.536	-26.833	6.379	-2.757
6	168.082	-20.785	712.5	-13.454	-58.115	40.358	62.046
7	-186.446	12.124	-363.0	12.538	-40.694	26.833	44.449
8	37.500	-18.187	523.5	-14.722	-46.237	45.040	35.172
9	-133.000	-17.321	-154.5	6.500	-58.070	9.360	42.280
10	-74.483	18.187	-160.0	8.485	-18.879	50.163	19.598
11	-24.042	13.608	-236.0	5.464	-23.394	-19.964	47.846
12	101.116	-24.000	-12.0	-9.928	-5.612	87.406	13.609
13	-105.558	-6.062	-358.5	13.504	-43.140	36.144	31.110
14	-186.758	-25.569	823.5	-8.062	-49.566	2.821	72.707
15	16.291	8.785	-250.0	5.536	-25.887	-2.212	35.211
16	-156.000	12.124	216.0	-10.392	16.052	56.073	4.535
17	-104.500	12.124	168.0	-8.660	17.862	53.938	16.815
18	119.512	13.856	-300.0	11.314	-31.165	8.417	16.496
19	-18.635	12.124	-79.5	9.262	-8.477	65.979	3.888
20	200.052	-18.187	-171.5	6.500	-8.878	5.918	-6.210
21	-217.679	16.000	-415.5	13.125	-39.827	37.056	48.545
22	-11.937	-18.187	-328.0	11.314	-11.408	39.592	27.234
23	-10.800	-20.785	-230.0	4.000	-42.704	10.487	57.896
24	225.167	-31.177	152.2	-11.258	-10.267	78.806	28.534
25	-111.865	15.000	4.0	2.804	-58.627	28.265	38.470
26	-76.977	-6.928	493.5	-14.722	-22.032	23.406	26.123
27	295.315	-23.383	712.5	-13.454	-60.155	40.091	71.309
28	-33.775	-17.569	-569.0	9.054	-46.045	24.714	62.996
29	21.920	-12.000	-35.5	5.036	-8.942	1.051	8.058
30	-161.500	20.785	-367.5	9.830	-41.683	19.539	46.613