

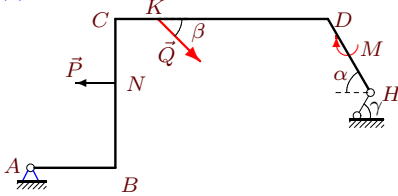
## Определение реакций опор рамы

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**/Под ред. А. И. Кириллова.– М.: ФИЗМАТЛИТ, 2008. — 384 с. (с.31.)

### Задача S4.1.

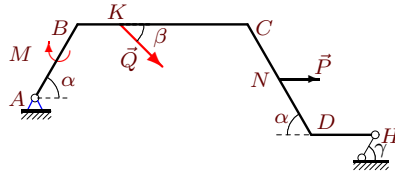
6



$\rho = 2$  кН/м,  $P = 6$  кН,  $Q = 28$  кН,  
 $M = 20$  кНм,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4$  м,  $BC = 7$  м,  $CD = 10$  м,  
 $DH = 4$  м,  $CK = 2$  м,  $CN = 3$  м.

### Задача S4.2.

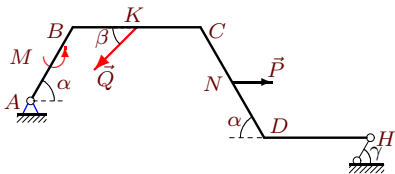
6



$\rho = 1$  кН/м,  $P = 5$  кН,  $Q = 25$  кН,  
 $M = 15$  кНм,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4$  м,  $BC = 8$  м,  $CD = 6$  м,  
 $DH = 3$  м,  $BK = 2$  м,  $CN = 3$  м.

### Задача S4.3.

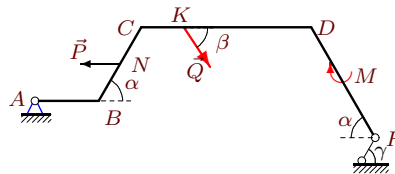
6



$\rho = 2$  кН/м,  $P = 7$  кН,  $Q = 17$  кН,  
 $M = 50$  кНм,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4$  м,  $BC = 6$  м,  $CD = 6$  м,  
 $DH = 5$  м,  $BK = 3$  м,  $CN = 3$  м.

### Задача S4.4.

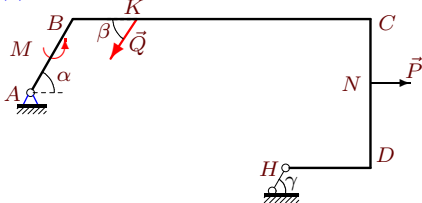
6



$\rho = 2$  кН/м,  $P = 8$  кН,  $Q = 22$  кН,  
 $M = 20$  кНм,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 3$  м,  $BC = 4$  м,  $CD = 8$  м,  
 $DH = 6$  м,  $CK = 2$  м,  $CN = 2$  м.

### Задача S4.5.

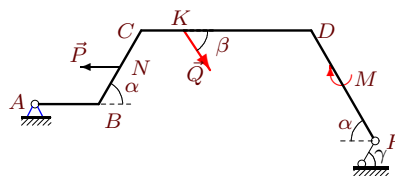
6



$\rho = 1$  кН/м,  $P = 7$  кН,  $Q = 15$  кН,  
 $M = 30$  кНм,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4$  м,  $BC = 14$  м,  $CD = 7$  м,  
 $DH = 4$  м,  $BK = 3$  м,  $CN = 3$  м.

### Задача S4.6.

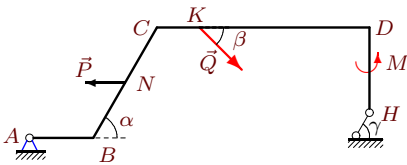
6



$\rho = 2$  кН/м,  $P = 8$  кН,  $Q = 24$  кН,  
 $M = 20$  кНм,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 3$  м,  $BC = 4$  м,  $CD = 8$  м,  
 $DH = 6$  м,  $CK = 2$  м,  $CN = 2$  м.

**Задача S4.7.**

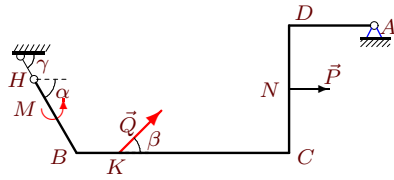
6



$\rho = 2 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  $Q = 14 \text{ кН}$ ,  
 $M = 50 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 3 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  $CD = 10 \text{ м}$ ,  
 $DH = 4 \text{ м}$ ,  $CK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.8.**

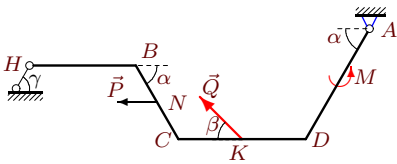
6



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 11 \text{ кН}$ ,  
 $M = 70 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 4 \text{ м}$ ,  $BC = 10 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DA = 4 \text{ м}$ ,  $BK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.9.**

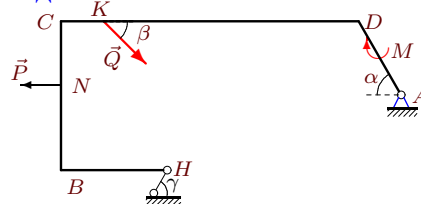
6



$\rho = 3 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  $Q = 21 \text{ кН}$ ,  
 $M = 70 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 5 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DA = 6 \text{ м}$ ,  $CK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.10.**

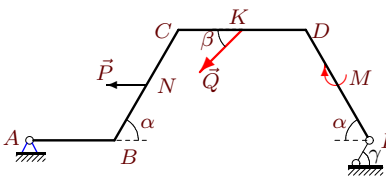
6



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 30 \text{ кН}$ ,  
 $M = 25 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 5 \text{ м}$ ,  $BC = 7 \text{ м}$ ,  $CD = 14 \text{ м}$ ,  
 $DA = 4 \text{ м}$ ,  $CK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.11.**

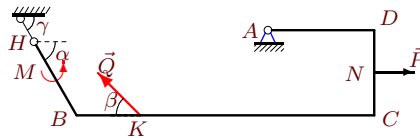
6



$\rho = 2 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  $Q = 22 \text{ кН}$ ,  
 $M = 20 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DH = 6 \text{ м}$ ,  $CK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.12.**

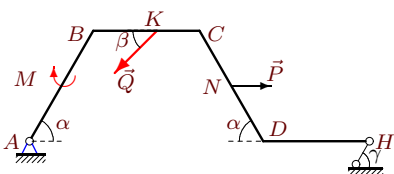
6



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 15 \text{ кН}$ ,  
 $M = 70 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 4 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  $CD = 4 \text{ м}$ ,  
 $DA = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.13.**

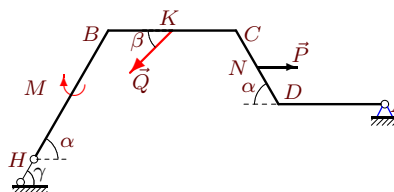
6



$\rho = 2 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  $Q = 25 \text{ кН}$ ,  
 $M = 20 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 5 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DH = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.14.**

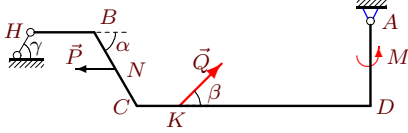
6



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 24 \text{ кН}$ ,  
 $M = 25 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 7 \text{ м}$ ,  $BC = 6 \text{ м}$ ,  $CD = 4 \text{ м}$ ,  
 $DA = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.15.**

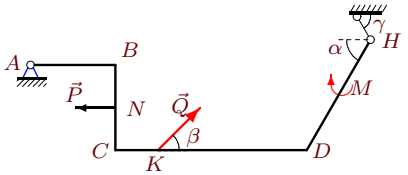
6



$\rho = 3 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  $Q = 12 \text{ кН}$ ,  
 $M = 70 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 3 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  $CD = 11 \text{ м}$ ,  
 $DA = 4 \text{ м}$ ,  $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.17.**

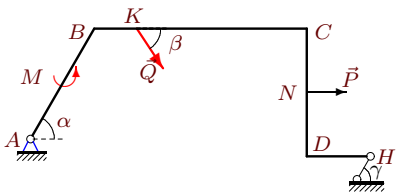
6



$\rho = 1 \text{ кН/м}$ ,  $P = 5 \text{ кН}$ ,  $Q = 27 \text{ кН}$ ,  
 $M = 15 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  $CD = 9 \text{ м}$ ,  
 $DH = 6 \text{ м}$ ,  $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.19.**

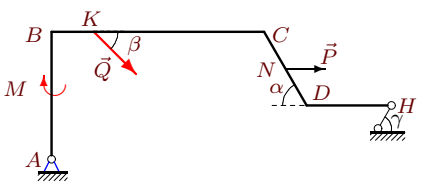
6



$\rho = 2 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 12 \text{ кН}$ ,  
 $M = 50 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 10 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DH = 3 \text{ м}$ ,  $BK = 2 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.21.**

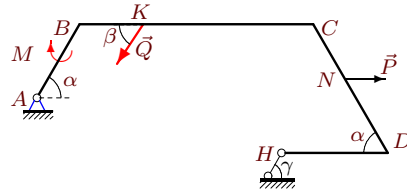
6



$\rho = 1 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  $Q = 31 \text{ кН}$ ,  
 $M = 15 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 10 \text{ м}$ ,  $CD = 4 \text{ м}$ ,  
 $DH = 4 \text{ м}$ ,  $BK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.16.**

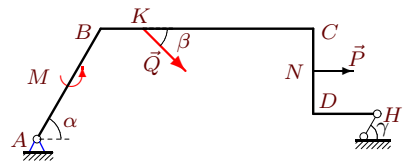
6



$\rho = 2 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 24 \text{ кН}$ ,  
 $M = 20 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 11 \text{ м}$ ,  $CD = 7 \text{ м}$ ,  
 $DH = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.18.**

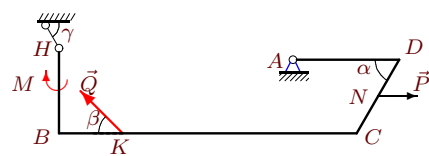
6



$\rho = 1 \text{ кН/м}$ ,  $P = 5 \text{ кН}$ ,  $Q = 11 \text{ кН}$ ,  
 $M = 30 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 10 \text{ м}$ ,  $CD = 4 \text{ м}$ ,  
 $DH = 3 \text{ м}$ ,  $BK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.20.**

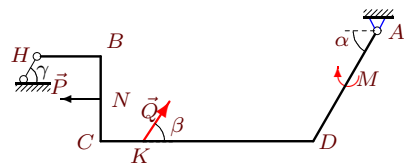
6



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 33 \text{ кН}$ ,  
 $M = 25 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 4 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  $CD = 4 \text{ м}$ ,  
 $DA = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.22.**

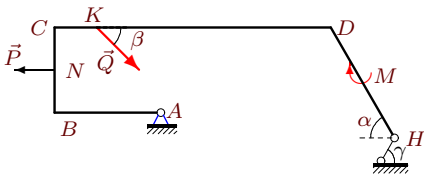
6



$\rho = 3 \text{ кН/м}$ ,  $P = 9 \text{ кН}$ ,  $Q = 31 \text{ кН}$ ,  
 $M = 25 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 3 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  $CD = 10 \text{ м}$ ,  
 $DA = 6 \text{ м}$ ,  $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.23.**

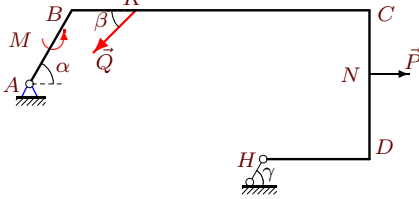
6



$\rho = 2 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  $Q = 30 \text{ кН}$ ,  
 $M = 20 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 5 \text{ м}$ ,  $BC = 4 \text{ м}$ ,  $CD = 13 \text{ м}$ ,  
 $DH = 6 \text{ м}$ ,  $CK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.25.**

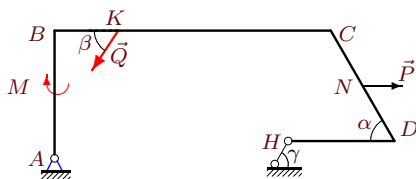
6



$\rho = 1 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  $Q = 13 \text{ кН}$ ,  
 $M = 30 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  $CD = 7 \text{ м}$ ,  
 $DH = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.27.**

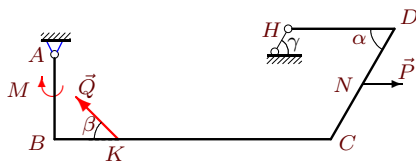
6



$\rho = 1 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  $Q = 27 \text{ кН}$ ,  
 $M = 15 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 6 \text{ м}$ ,  $BC = 13 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DH = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.29.**

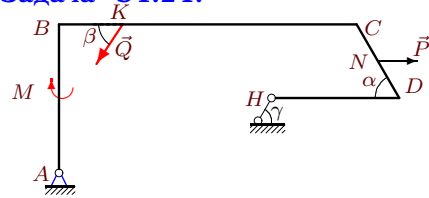
6



$\rho = 2 \text{ кН/м}$ ,  $P = 6 \text{ кН}$ ,  $Q = 28 \text{ кН}$ ,  
 $M = 20 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 45^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 13 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DH = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.24.**

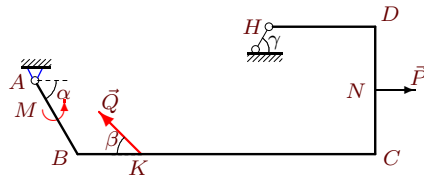
6



$\rho = 1 \text{ кН/м}$ ,  $P = 7 \text{ кН}$ ,  $Q = 35 \text{ кН}$ ,  
 $M = 15 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 60^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 7 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  $CD = 4 \text{ м}$ ,  
 $DH = 6 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**Задача S4.26.**

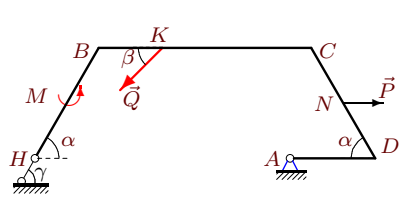
6



$\rho = 1 \text{ кН/м}$ ,  $P = 5 \text{ кН}$ ,  $Q = 11 \text{ кН}$ ,  
 $M = 30 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 14 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DH = 5 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.28.**

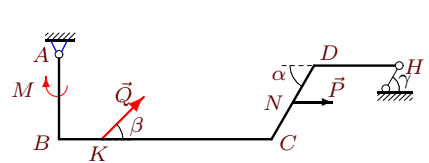
6



$\rho = 3 \text{ кН/м}$ ,  $P = 8 \text{ кН}$ ,  $Q = 16 \text{ кН}$ ,  
 $M = 70 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 45^\circ$ ,  $\gamma = 60^\circ$ ,  
 $HB = 6 \text{ м}$ ,  $BC = 10 \text{ м}$ ,  $CD = 6 \text{ м}$ ,  
 $DA = 4 \text{ м}$ ,  $BK = 3 \text{ м}$ ,  $CN = 3 \text{ м}$ .

**Задача S4.30.**

6



$\rho = 1 \text{ кН/м}$ ,  $P = 5 \text{ кН}$ ,  $Q = 31 \text{ кН}$ ,  
 $M = 15 \text{ кНм}$ ,  $\alpha = 60^\circ$ ,  $\beta = 30^\circ$ ,  $\gamma = 30^\circ$ ,  
 $AB = 4 \text{ м}$ ,  $BC = 10 \text{ м}$ ,  $CD = 4 \text{ м}$ ,  
 $DH = 4 \text{ м}$ ,  $BK = 2 \text{ м}$ ,  $CN = 2 \text{ м}$ .

**S4 Ответы.**  
**Определение реакций опор рамы**

04.03.2012

	$M_A(Q)$	$M_A(P)$	$\Sigma_k M_A(G_k)$	$h$	$X_A$	$Y_A$	$R_H$
1	-253.741	24.000	-372.0	8.813	-68.131	14.117	70.545
2	-125.000	-4.330	-164.5	9.500	-54.804	17.246	32.508
3	-18.463	-6.062	-317.0	12.538	-11.420	37.580	23.250
4	-171.473	13.856	-359.0	12.538	-33.263	30.790	42.798
5	-38.971	-3.249	-298.0	9.062	-29.146	24.874	34.232
6	-187.061	13.856	-359.0	12.538	-35.142	31.643	44.041
7	-119.000	15.588	-411.0	10.468	-37.495	21.629	44.365
8	-46.669	24.000	546.0	-15.124	3.837	30.248	39.230
9	-157.500	-24.249	457.5	-12.990	11.879	29.450	26.616
10	223.500	3.713	928.5	-7.758	-86.084	-15.003	145.742
11	-74.730	18.187	-376.0	11.314	-5.728	31.272	40.000
12	-106.066	16.000	106.5	-9.794	7.019	62.751	8.825
13	-14.210	-18.187	-322.0	11.314	-12.722	38.278	33.092
14	228.493	-13.856	599.3	-12.990	-21.394	30.378	60.729
15	-12.431	-15.876	456.0	-13.588	-21.705	28.281	36.626
16	-62.354	-6.928	-519.5	9.969	-39.182	31.603	61.068
17	174.531	-10.000	-187.5	9.036	-14.744	7.399	4.202
18	-77.000	-15.981	-184.5	6.964	-45.302	10.732	35.537
19	-83.138	-17.569	-421.0	11.882	-42.071	32.321	39.699
20	-267.509	13.856	214.5	-9.258	11.870	63.666	-6.929
21	-175.362	-25.608	-150.0	5.804	-82.529	14.392	63.056
22	-214.774	-28.765	553.5	-13.258	-17.246	23.540	21.493
23	-58.923	12.000	-88.0	8.624	-32.683	58.297	17.964
24	31.567	-36.876	-236.0	1.938	-104.046	-4.822	132.266
25	-14.119	-2.785	-309.5	8.562	-26.787	21.884	34.618
26	-5.500	2.321	-293.5	3.304	-65.377	-16.859	80.718
27	10.852	-23.813	-239.0	4.804	-41.627	25.596	55.572
28	126.670	-20.785	240.0	-10.392	-16.696	54.657	40.019
29	-54.995	8.412	-478.0	6.932	-37.299	-13.548	78.557
30	138.387	11.340	-150.0	8.464	-33.409	5.598	1.804

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