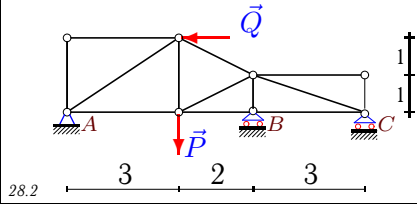


Расчет статически неопределимой фермы

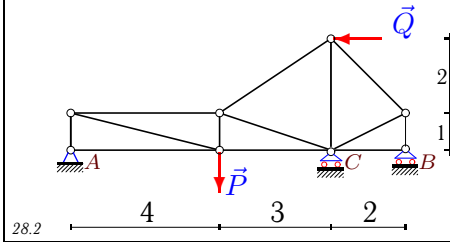
Задача 28.1



$P = 6 \text{ кН},$
 $Q = 3 \text{ кН}.$

28.2

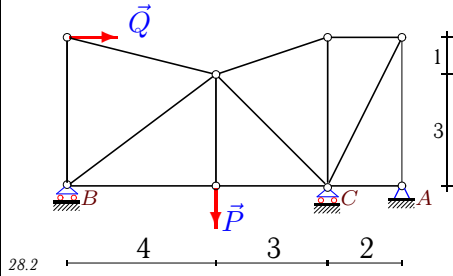
Задача 28.2



$P = 8 \text{ кН},$
 $Q = 9 \text{ кН}.$

28.2

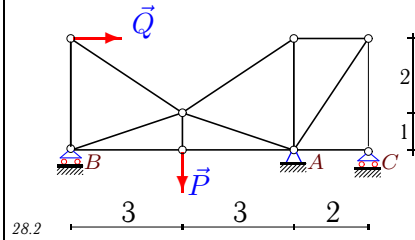
Задача 28.3



$P = 7 \text{ кН},$
 $Q = 7 \text{ кН}.$

28.2

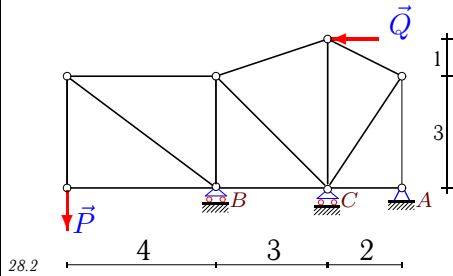
Задача 28.4



$P = 8 \text{ кН},$
 $Q = 4 \text{ кН}.$

28.2

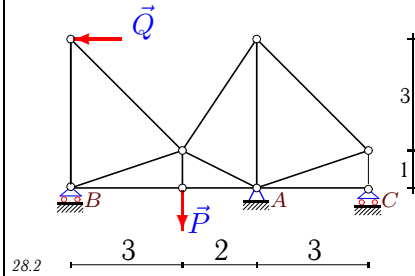
Задача 28.5



$P = 8 \text{ кН},$
 $Q = 3 \text{ кН}.$

28.2

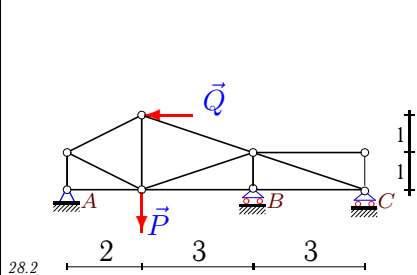
Задача 28.6



$P = 10 \text{ кН},$
 $Q = 9 \text{ кН}.$

28.2

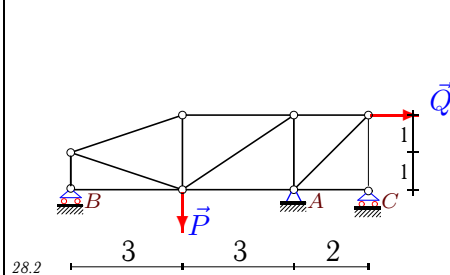
Задача 28.7



$P = 8 \text{ кН},$
 $Q = 9 \text{ кН}.$

28.2

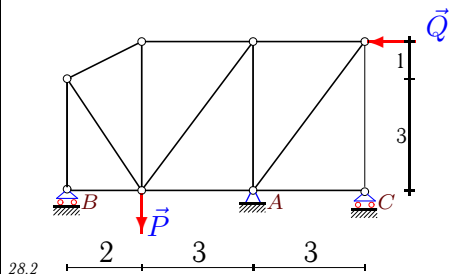
Задача 28.8



$P = 13 \text{ кН},$
 $Q = 6 \text{ кН}.$

28.2

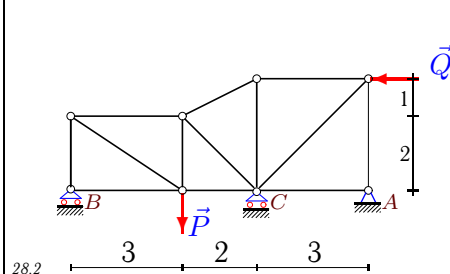
Задача 28.9



$P = 11 \text{ кН},$
 $Q = 9 \text{ кН}.$

28.2

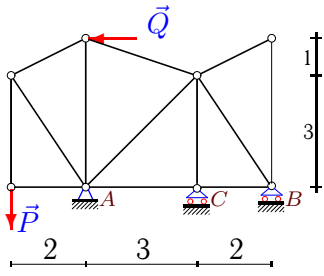
Задача 28.10



$P = 8 \text{ кН},$
 $Q = 8 \text{ кН}.$

28.2

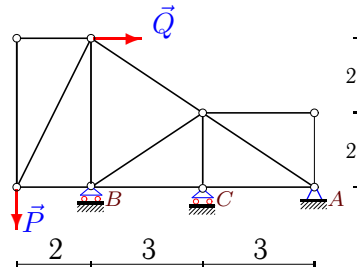
Задача 28.11



$P = 8 \text{ кН},$
 $Q = 3 \text{ кН}.$

28.2

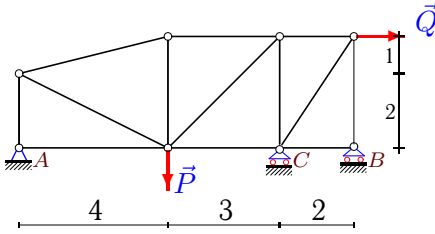
Задача 28.12



$P = 8 \text{ кН},$
 $Q = 7 \text{ кН}.$

28.2

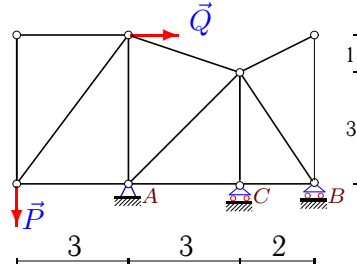
Задача 28.13



$P = 13 \text{ кН},$
 $Q = 6 \text{ кН}.$

28.2

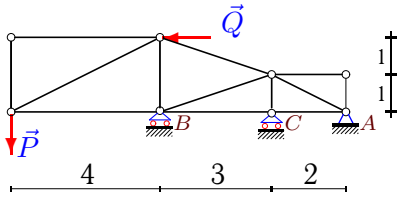
Задача 28.14



$P = 9 \text{ кН},$
 $Q = 8 \text{ кН}.$

28.2

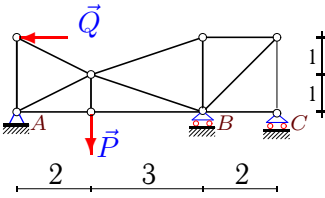
Задача 28.15



$P = 5 \text{ кН},$
 $Q = 4 \text{ кН}.$

28.2

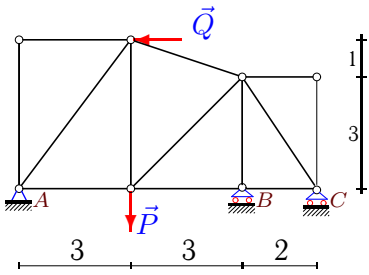
Задача 28.16



$P = 9 \text{ кН},$
 $Q = 9 \text{ кН}.$

28.2

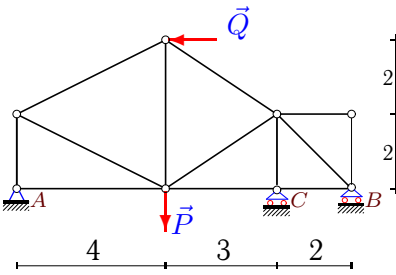
Задача 28.17



$P = 11 \text{ кН},$
 $Q = 8 \text{ кН}.$

28.2

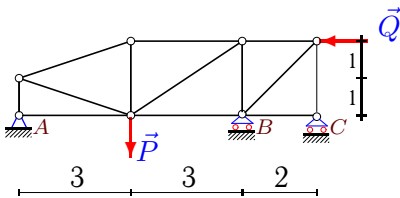
Задача 28.18



$P = 10 \text{ кН},$
 $Q = 3 \text{ кН}.$

28.2

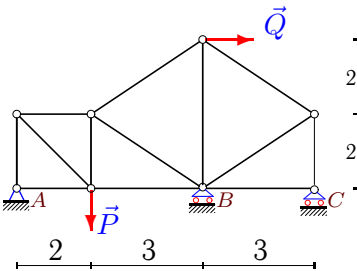
Задача 28.19



$P = 11 \text{ кН},$
 $Q = 5 \text{ кН}.$

28.2

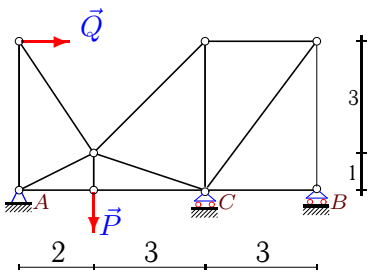
Задача 28.20



$P = 13 \text{ кН},$
 $Q = 9 \text{ кН}.$

28.2

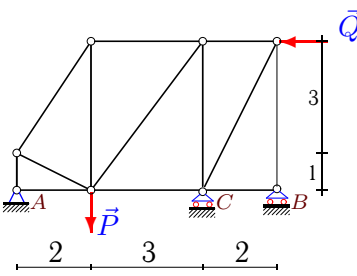
Задача 28.21



$P = 7 \text{ кН},$
 $Q = 8 \text{ кН}.$

28.2

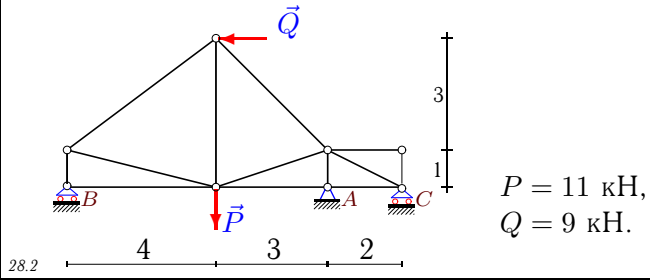
Задача 28.22



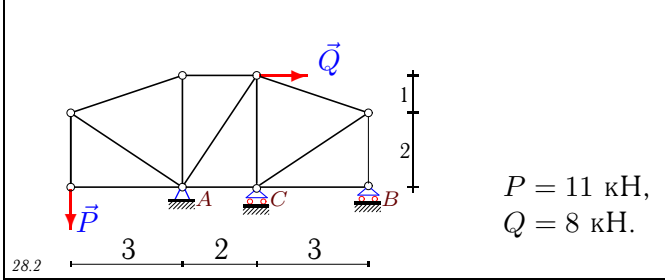
$P = 12 \text{ кН},$
 $Q = 4 \text{ кН}.$

28.2

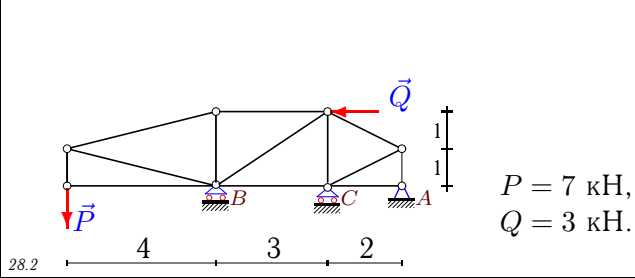
Задача 28.23



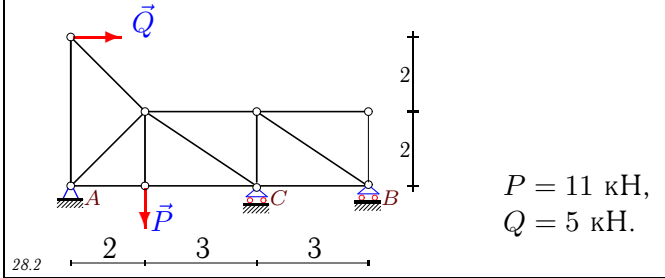
Задача 28.24



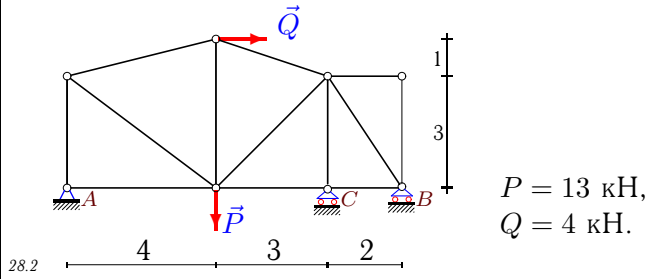
Задача 28.25



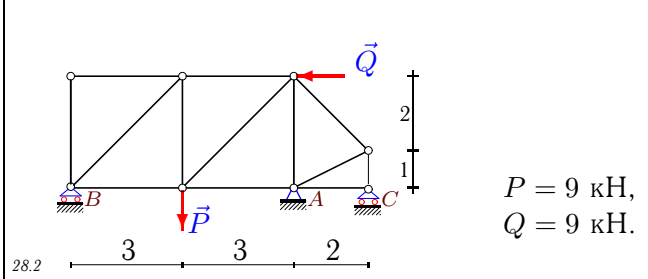
Задача 28.26



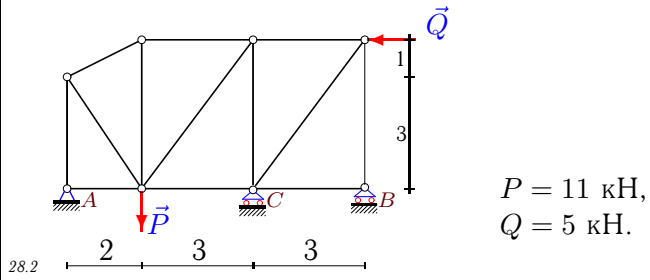
Задача 28.27



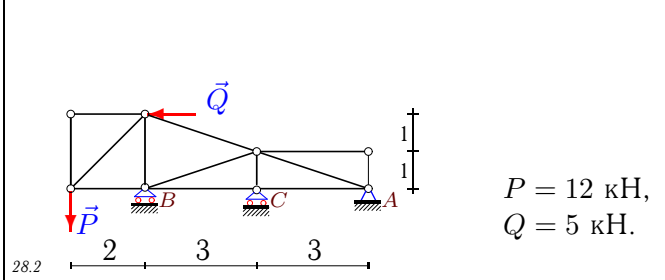
Задача 28.28



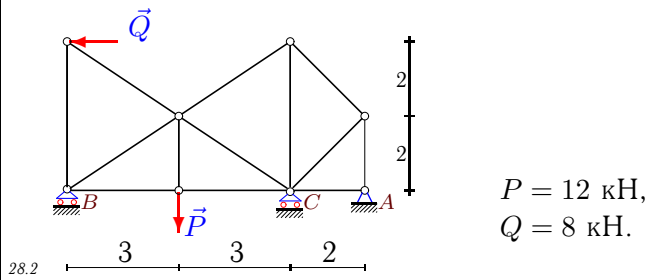
Задача 28.29



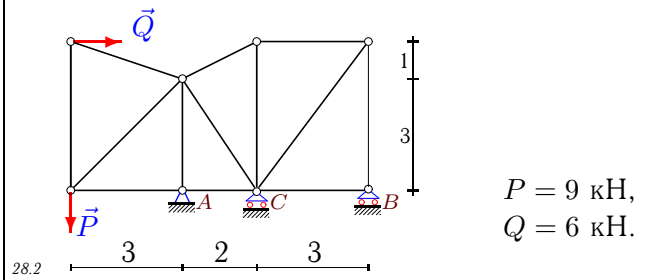
Задача 28.30



Задача 28.31



Задача 28.32



Расчет статически неопределимой фермы

| | δ_{11} | Δ_{1P} | X_A | Y_A | Y_B | Y_C |
|----|---------------|---------------|--------|--------|---------|--------|
| 1 | 102.627 | 29.981 | 3.000 | 3.425 | 2.867 | -0.292 |
| 2 | 16.091 | -349.843 | 9.000 | 2.613 | -16.354 | 21.741 |
| 3 | 8.076 | -62.709 | -7.000 | 0.183 | -0.948 | 7.765 |
| 4 | 21.908 | 154.273 | -4.000 | 15.389 | -0.347 | -7.042 |
| 5 | 4.196 | 4.991 | 3.000 | -8.086 | 17.276 | -1.189 |
| 6 | 59.069 | 94.098 | 9.000 | 1.349 | 10.244 | -1.593 |
| 7 | 112.559 | 41.649 | 9.000 | 8.178 | 0.192 | -0.370 |
| 8 | 16.855 | -32.776 | -6.000 | 5.907 | 5.148 | 1.945 |
| 9 | 22.186 | 123.507 | 9.000 | 6.107 | 10.460 | -5.567 |
| 10 | 10.858 | -106.215 | 8.000 | -6.114 | 4.332 | 9.783 |
| 11 | 7.033 | 13.878 | 3.000 | 14.389 | -4.416 | -1.973 |
| 12 | 11.234 | 6.282 | -7.000 | 2.280 | 6.280 | -0.559 |
| 13 | 8.131 | -66.491 | -6.000 | 3.405 | 1.417 | 8.178 |
| 14 | 7.033 | -2.478 | -8.000 | 7.859 | 0.789 | 0.352 |
| 15 | 17.285 | 68.960 | 4.000 | -3.206 | 12.196 | -3.990 |
| 16 | 18.522 | 20.125 | 9.000 | 8.565 | 1.521 | -1.087 |
| 17 | 16.206 | 45.432 | 8.000 | 9.899 | 3.904 | -2.803 |
| 18 | 11.231 | -54.475 | 3.000 | 5.811 | -0.661 | 4.850 |
| 19 | 16.855 | 49.951 | 5.000 | 6.179 | 7.785 | -2.964 |
| 20 | 20.182 | -60.777 | -9.000 | 2.407 | 7.582 | 3.011 |
| 21 | 12.679 | -288.513 | -8.000 | -7.283 | -8.471 | 22.754 |
| 22 | 7.118 | -31.512 | 4.000 | 9.592 | -2.020 | 4.427 |
| 23 | 45.929 | 103.102 | 9.000 | 4.029 | 9.216 | -2.245 |
| 24 | 5.524 | 0.895 | -8.000 | 12.897 | -1.735 | -0.162 |
| 25 | 6.307 | -2.905 | 3.000 | -7.076 | 13.616 | 0.461 |
| 26 | 13.779 | -118.575 | -5.000 | 2.523 | -0.129 | 8.606 |
| 27 | 9.231 | -60.678 | -4.000 | 3.984 | 2.443 | 6.573 |
| 28 | 11.975 | 70.456 | 9.000 | 7.845 | 7.039 | -5.883 |
| 29 | 8.666 | -39.048 | 5.000 | 9.060 | -2.566 | 4.506 |
| 30 | 30.311 | 197.598 | 5.000 | -2.407 | 20.926 | -6.519 |
| 31 | 6.587 | -42.218 | 8.000 | -4.307 | 9.898 | 6.409 |
| 32 | 4.636 | -15.461 | -6.000 | 7.599 | -1.934 | 3.335 |

В первой строке — усилия от действия основной нагрузки, во второй — от единичной силы в опоре C .

| | 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 | X_A | Y_A | Y_B |
|----|--------|--------|--------|--------|--------|-------|-------|--------|--------|-------|--------|--------|-------|-------|-------|-------|
| 1 | 2.40 | 0.00 | 0.00 | 0.00 | 4.80 | -2.40 | 0.00 | 0.00 | -2.68 | 0.00 | -6.49 | 2.68 | 0.00 | 3.00 | 3.60 | 2.40 |
| | 0.90 | 3.00 | 3.00 | 0.00 | 1.05 | 1.60 | 0.00 | 0.00 | -1.01 | -0.00 | -1.08 | -2.35 | -3.16 | 0.00 | 0.60 | -1.60 |
| 2 | -9.00 | 20.78 | 0.00 | -7.44 | 0.56 | 6.62 | -0.56 | -29.78 | -11.26 | -0.52 | 30.69 | -21.51 | 0.41 | 9.00 | 7.44 | 0.56 |
| | 0.00 | -0.89 | 0.00 | 0.22 | 0.22 | -0.86 | 0.78 | 0.89 | 0.62 | 0.73 | -0.92 | 0.39 | -0.58 | 0.00 | -0.22 | -0.78 |
| 3 | 3.37 | 3.37 | -7.00 | 1.75 | 7.00 | 1.04 | -6.22 | -7.22 | -3.28 | -3.11 | -4.21 | -10.27 | 6.96 | -7.00 | 6.22 | 0.78 |
| | -0.30 | -0.30 | 0.00 | -0.00 | 0.00 | -0.13 | 0.78 | 0.00 | 0.41 | 0.39 | 0.37 | -0.13 | -0.87 | 0.00 | -0.78 | -0.22 |
| 4 | 14.00 | 14.00 | 0.00 | 2.67 | 8.00 | 0.00 | 0.00 | -4.81 | -0.00 | -0.00 | -14.76 | -18.97 | 0.00 | -4.00 | 6.00 | 2.00 |
| | 1.00 | 1.00 | 0.00 | -0.00 | 0.00 | 0.44 | -1.00 | 0.00 | -0.80 | -0.67 | -1.05 | -0.35 | 1.20 | 0.00 | -1.33 | 0.33 |
| 5 | 0.00 | -10.67 | 3.00 | 8.00 | -8.80 | -2.67 | 8.80 | 10.67 | 1.48 | 4.92 | -13.33 | 13.11 | -7.93 | 3.00 | -8.80 | 16.80 |
| | 0.00 | 0.00 | -0.00 | 0.00 | 0.40 | -0.25 | 0.60 | -0.00 | 0.32 | 0.34 | 0.00 | -0.42 | -0.54 | 0.00 | -0.60 | -0.40 |
| 6 | 6.60 | 6.60 | 0.00 | -9.00 | 10.00 | 0.00 | 0.00 | 12.73 | 0.00 | 0.00 | -6.96 | 2.68 | 0.00 | 9.00 | -1.20 | 11.20 |
| | 1.80 | 1.80 | -0.00 | 0.00 | 0.00 | 1.88 | -1.00 | 0.00 | -1.35 | -1.06 | -1.90 | -1.17 | 0.79 | 0.00 | -1.60 | 0.60 |
| 7 | -9.00 | 0.00 | 0.00 | -8.40 | 4.00 | 0.40 | -0.00 | -9.39 | 0.63 | 0.00 | 9.39 | -0.63 | 0.00 | 9.00 | 8.40 | -0.40 |
| | 0.00 | 3.00 | 3.00 | -0.60 | 0.50 | 1.60 | 0.00 | -0.67 | -0.63 | 0.00 | 0.67 | -2.53 | -3.16 | 0.00 | 0.60 | -1.60 |
| 8 | 0.00 | -6.00 | 0.00 | -4.50 | 2.25 | -8.50 | 0.00 | -7.12 | -6.75 | 6.00 | 7.12 | 15.32 | 0.00 | -6.00 | 8.50 | 4.50 |
| | 0.00 | 1.00 | -0.00 | -0.33 | 0.17 | 0.33 | -1.00 | -0.53 | -0.50 | -1.00 | 0.53 | -0.60 | 1.41 | 0.00 | -1.33 | 0.33 |
| 9 | 0.00 | 9.00 | 0.00 | -13.80 | 3.45 | 2.80 | 0.00 | -7.71 | -6.90 | -9.00 | 12.44 | -3.50 | -0.00 | 9.00 | -2.80 | 13.80 |
| | 0.00 | 0.75 | 0.00 | -0.60 | 0.15 | 0.60 | -1.00 | -0.34 | -0.30 | -0.75 | 0.54 | -0.75 | 1.25 | 0.00 | -1.60 | 0.60 |
| 10 | 0.00 | 12.00 | 8.00 | -8.00 | 0.00 | 4.00 | -0.00 | -12.00 | -8.94 | -8.00 | 14.42 | -5.66 | 0.00 | 8.00 | 0.00 | 8.00 |
| | 0.00 | -0.56 | 0.00 | 0.37 | 0.37 | -0.31 | 0.62 | 0.56 | 0.70 | 0.62 | -0.68 | -0.09 | -0.88 | 0.00 | -0.62 | -0.37 |
| 11 | 0.00 | -3.73 | -3.73 | 8.00 | -4.33 | 0.00 | -0.00 | 4.47 | 7.38 | -0.00 | -7.21 | -4.62 | 6.73 | 3.00 | 13.60 | -5.60 |
| | 0.00 | -0.40 | -0.40 | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.57 | 0.72 | 0.00 | -0.40 | -0.60 |
| 12 | -4.00 | -4.00 | -4.00 | 0.00 | -6.00 | 0.00 | -0.00 | 0.00 | -3.61 | -0.00 | 8.94 | 0.00 | -3.61 | -7.00 | 2.00 | 6.00 |
| | 0.00 | -0.75 | -0.75 | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 | 0.00 | -0.00 | 0.00 | 0.90 | 0.90 | 0.00 | -0.50 | -0.50 |
| 13 | 6.00 | 5.19 | -0.00 | -5.22 | 1.74 | -7.78 | -7.78 | -7.18 | -6.96 | 0.81 | 7.78 | 11.00 | 9.35 | -6.00 | 5.22 | 7.78 |
| | 0.00 | -0.52 | 0.00 | 0.22 | -0.07 | -0.22 | 0.78 | 0.31 | 0.30 | 0.52 | -0.33 | 0.31 | -0.93 | 0.00 | -0.22 | -0.78 |
| 14 | -6.75 | 0.67 | 0.67 | -0.00 | -8.58 | 0.00 | -0.00 | 0.00 | -1.32 | 0.00 | 11.25 | 0.82 | -1.20 | -8.00 | 8.00 | 1.00 |
| | 0.00 | -0.40 | -0.40 | 0.00 | 0.00 | -1.00 | -0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.57 | 0.72 | 0.00 | -0.40 | -0.60 |
| 15 | -10.00 | -7.20 | -7.20 | -0.00 | -9.67 | 0.00 | 0.00 | 0.00 | 14.76 | 0.00 | 11.18 | -2.95 | 12.52 | 4.00 | -5.60 | 10.60 |
| | 0.00 | -1.20 | -1.20 | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 | -0.00 | 0.00 | -0.00 | 1.26 | 1.34 | 0.00 | -0.60 | -0.40 |
| 16 | 0.00 | 0.00 | 0.00 | -4.50 | 9.00 | 0.00 | 0.00 | 10.06 | 0.00 | 0.00 | -10.06 | 0.00 | -0.00 | 9.00 | 9.00 | -0.00 |
| | 0.80 | 0.80 | -0.00 | -0.00 | 0.00 | 0.33 | -1.00 | 0.00 | -1.05 | -1.00 | -0.89 | 0.21 | 1.41 | 0.00 | 0.40 | -1.40 |
| 17 | 0.13 | 0.00 | 0.00 | 0.00 | 10.88 | -0.17 | 0.00 | 0.00 | -0.13 | 0.00 | -13.54 | 0.18 | 0.00 | 8.00 | 10.83 | 0.17 |
| | 0.25 | 0.67 | 0.67 | 0.00 | 0.42 | 1.33 | 0.00 | 0.00 | -0.26 | -0.00 | -0.42 | -0.59 | -1.20 | 0.00 | 0.33 | -1.33 |
| 18 | -3.00 | 3.11 | 3.11 | -6.89 | 6.04 | 0.00 | 0.00 | -7.70 | -4.67 | -0.00 | 7.70 | 0.93 | -4.40 | 3.00 | 6.89 | 3.11 |
| | 0.00 | -0.78 | -0.78 | 0.22 | -0.26 | -1.00 | 0.00 | 0.25 | 0.27 | -0.00 | -0.25 | 0.67 | 1.10 | 0.00 | -0.22 | -0.78 |
| 19 | -5.00 | 0.00 | 0.00 | -7.17 | 3.58 | -3.83 | 0.00 | -11.33 | -10.75 | -5.00 | 11.33 | 6.91 | 0.00 | 5.00 | 7.17 | 3.83 |
| | 0.00 | 1.00 | -0.00 | -0.33 | 0.17 | 0.33 | -1.00 | -0.53 | -0.50 | -1.00 | 0.53 | -0.60 | 1.41 | 0.00 | 0.33 | -1.33 |
| 20 | 9.00 | 9.60 | 0.00 | -0.60 | 12.40 | -6.00 | 0.00 | -0.60 | 10.82 | 0.00 | 0.85 | -11.54 | 0.00 | -9.00 | 0.60 | 12.40 |
| | 0.00 | 0.60 | -0.00 | -0.60 | -0.60 | 1.00 | -1.00 | -0.60 | -0.90 | -0.90 | 0.85 | 0.18 | 0.90 | 0.00 | 0.60 | -1.60 |
| 21 | 34.50 | 34.50 | -0.00 | 12.00 | 7.00 | 4.31 | -5.75 | -14.42 | -6.10 | -4.31 | -29.63 | -31.82 | 7.19 | -8.00 | 1.25 | 5.75 |
| | -0.75 | -0.75 | 0.00 | -0.00 | 0.00 | -0.47 | 0.63 | 0.00 | 0.66 | 0.47 | 0.84 | 0.30 | -0.78 | 0.00 | -0.38 | -0.63 |
| 22 | -4.00 | 0.57 | -0.00 | -10.86 | 8.14 | -1.14 | -1.14 | -9.79 | -5.43 | -4.57 | 6.07 | 1.43 | 1.28 | 4.00 | 10.86 | 1.14 |
| | 0.00 | -0.36 | 0.00 | 0.29 | -0.21 | -0.29 | 0.71 | 0.26 | 0.14 | 0.36 | -0.16 | 0.36 | -0.80 | 0.00 | -0.29 | -0.71 |
| 23 | 0.00 | 9.00 | 0.00 | -9.86 | 8.25 | -1.14 | 0.00 | -12.32 | -1.21 | 0.00 | 10.16 | 0.90 | 0.00 | 9.00 | 1.14 | 9.86 |
| | 0.00 | 2.00 | 2.00 | -0.29 | 0.50 | 1.29 | 0.00 | -0.36 | -0.40 | 0.00 | 0.29 | -1.81 | -2.24 | 0.00 | -1.29 | 0.29 |
| 24 | 0.00 | -1.80 | 0.00 | 11.00 | -3.67 | 1.20 | 1.80 | 11.60 | 11.00 | 1.90 | -13.22 | -2.16 | -2.16 | -8.00 | 12.80 | -1.80 |
| | 0.00 | -0.40 | 0.00 | 0.00 | 0.00 | -0.73 | 0.40 | 0.00 | 0.00 | 0.42 | -0.00 | 0.72 | -0.48 | 0.00 | -0.60 | -0.40 |
| 25 | 0.00 | -3.80 | 3.00 | 7.00 | -3.50 | 3.40 | 6.80 | 14.43 | 14.00 | 7.60 | -14.43 | -12.26 | -7.60 | 3.00 | -6.80 | 13.80 |
| | 0.00 | -0.60 | 0.00 | 0.00 | -0.00 | -0.70 | 0.60 | -0.00 | -0.00 | 0.67 | 0.00 | 0.72 | -0.67 | 0.00 | -0.60 | -0.40 |
| 26 | 15.75 | 15.75 | 7.88 | 5.00 | 11.00 | 5.25 | 0.00 | -7.07 | -7.88 | 0.00 | -15.20 | -9.46 | -9.46 | -5.00 | 5.75 | 5.25 |
| | -0.38 | -0.38 | -0.94 | 0.00 | 0.00 | -0.63 | 0.00 | 0.00 | 0.94 | 0.00 | 0.53 | -0.68 | 1.13 | 0.00 | -0.38 | -0.63 |
| 27 | 4.00 | 5.04 | 5.04 | -5.44 | 4.51 | 0.00 | -0.00 | -5.61 | -9.96 | -0.00 | 6.81 | 6.23 | -9.08 | -4.00 | 5.44 | 7.56 |
| | 0.00 | -0.52 | -0.52 | 0.22 | -0.13 | -1.00 | 0.00 | 0.23 | 0.23 | -0.00 | -0.28 | 0.42 | 0.93 | 0.00 | -0.22 | -0.78 |
| 28 | 9.00 | 9.00 | 0.00 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | -9.00 | 0.00 | -12.73 | 0.00 | 0.00 | 9.00 | 0.00 | 9.00 |
| | 0.33 | 0.67 | -0.00 | 0.00 | 0.33 | 1.00 | -1.00 | 0.00 | -0.33 | -0.94 | -0.47 | -0.47 | 0.75 | 0.00 | -1.33 | 0.33 |
| 29 | -5.00 | 0.19 | 0.00 | -10.75 | 2.69 | -0.25 | -0.25 | -6.01 | -5.38 | -5.19 | 9.69 | 0.31 | 0.31 | 5.00 | 10.75 | 0.25 |
| | 0.00 | -0.47 | -0.00 | 0.38 | -0.09 | -0.38 | 0.63 | 0.21 | 0.19 | 0.47 | -0.34 | 0.47 | -0.78 | 0.00 | -0.38 | -0.63 |
| 30 | -12.00 | -12.00 | -12.00 | 0.00 | -17.67 | 0.00 | 0.00 | 0.00 | 17.92 | 0.00 | 16.97 | 0.00 | 17.92 | 5.00 | -5.67 | 17.67 |
| | 0.00 | -1.50 | -1.50 | 0.00 | 0.00 | -1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.58 | 1.58 | 0.00 | -0.50 | -0.50 |
| 31 | 9.25 | 9.25 | 8.00 | -5.33 | 12.00 | 0.42 | -0.50 | 9.61 | -0.30 | -0.35 | -11.12 | -1.20 | 0.35 | 8.00 | 0.50 | 11.50 |
| | -0.37 | -0.37 | 0.00 | 0.00 | 0.00 | -0.63 | 0.75 | 0.00 | 0.45 | 0.53 | 0.45 | -0.00 | -0.53 | 0.00 | -0.75 | -0.25 |
| 32 | -7.00 | -1.00 | 0.00 | 2.00 | -9.60 | -0.23 | 0.60 | -6.32 | 0.50 | 0.45 | 9.90 | 0.99 | -0.75 | -6.00 | 9.60 | -0.60 |
| | 0.00 | 0.00 | -0.00 | 0.00 | 0.60 | -0.15 | 0.40 | 0.00 | 0.34 | 0.30 | -0.00 | -0.54 | -0.50 | 0.00 | -0.60 | -0.40 |