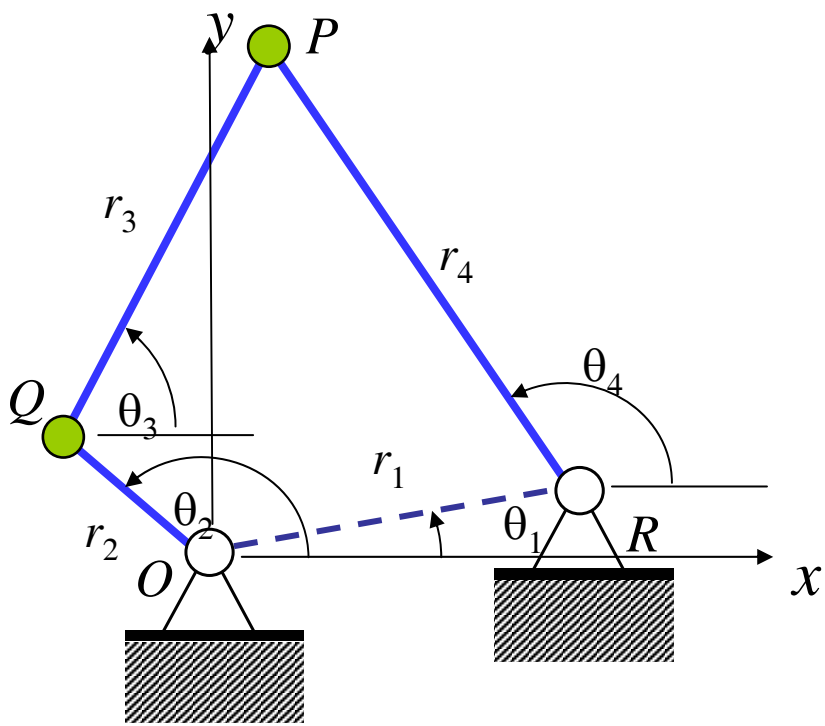
Four Bar Linkages

1. Types of linkages
2. Synthesis (Design)

Four Bar Linkage

- *Simplest 1 dof linkage*
- *Used very commonly*



Types of four bar linkages

Grashof Type I

- Crank rocker $s + l < p + q$
- Double-rocker
- Drag-link

Non-Grashof or Grashof Type II

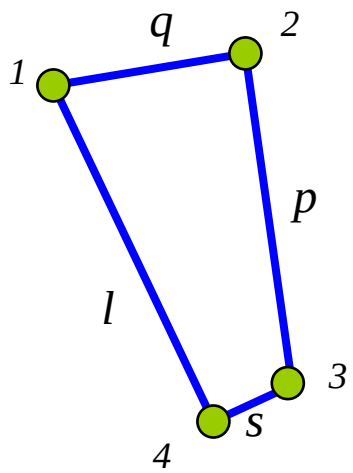
- Triple-rocker $s + l > p + q$

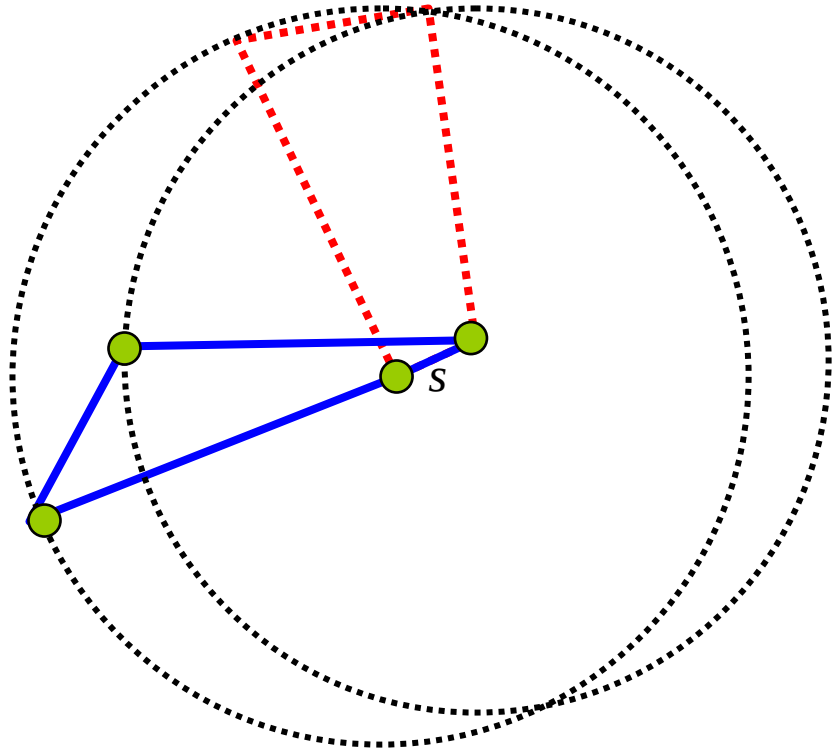
s = smallest link length
l = longest link length
p, q = other two lengths

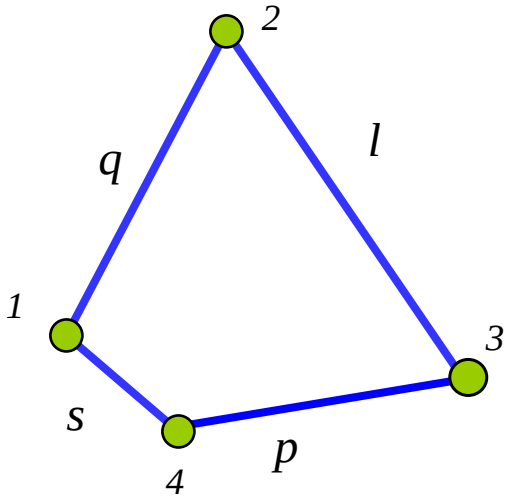
Facts

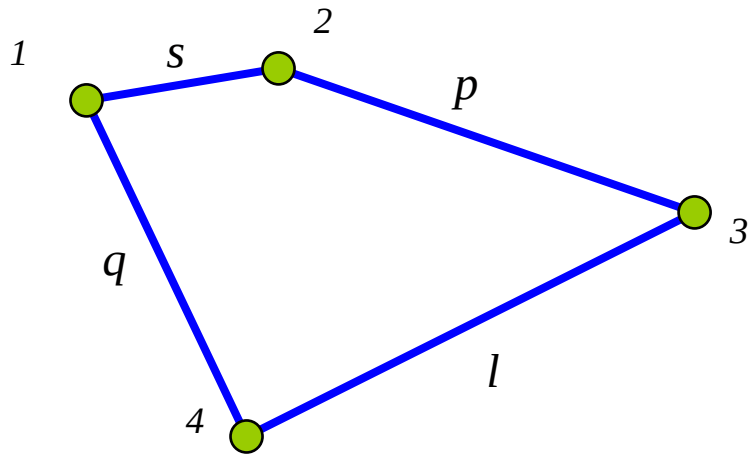
- Grashof linkages
  - There exists one link that completes a full 360 degree rotation relative to another link
  - This is the shortest link
  - The pair of joints connecting this link to other links are such that they rotate through 360 degrees
  - Three types of linkages
    - Crank rotates through 360 deg. (relative to frame)
    - Coupler rotates through 360 deg. (relative to frame)
    - Frame rotates through 360 deg. (relative to, let us say, crank)
- Non Grashof linkages
  - No link completes a full 360 degree rotation relative to another link

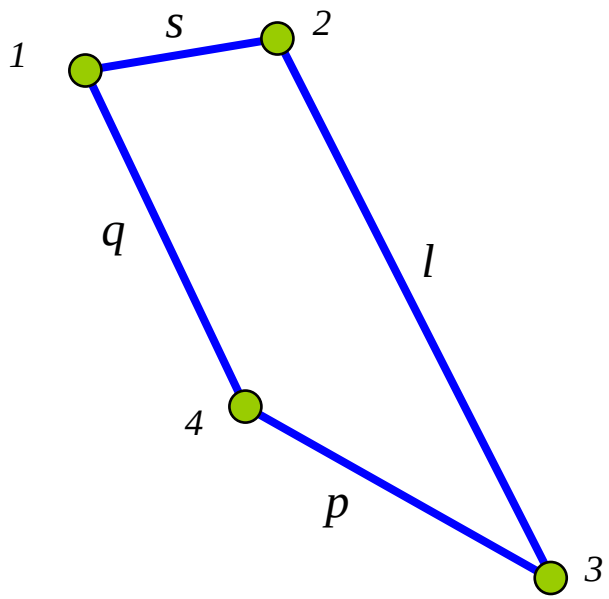
Geometric significance of Grashof Inequality

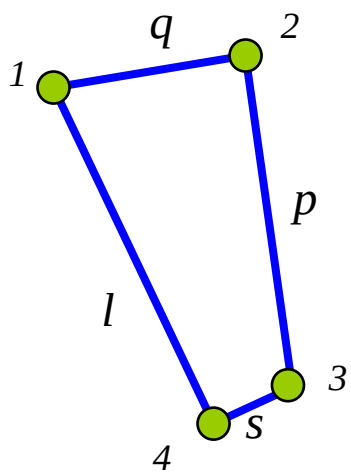





2
q
l
1
3
s
4
p


1
s
2
p
3
q
l
4

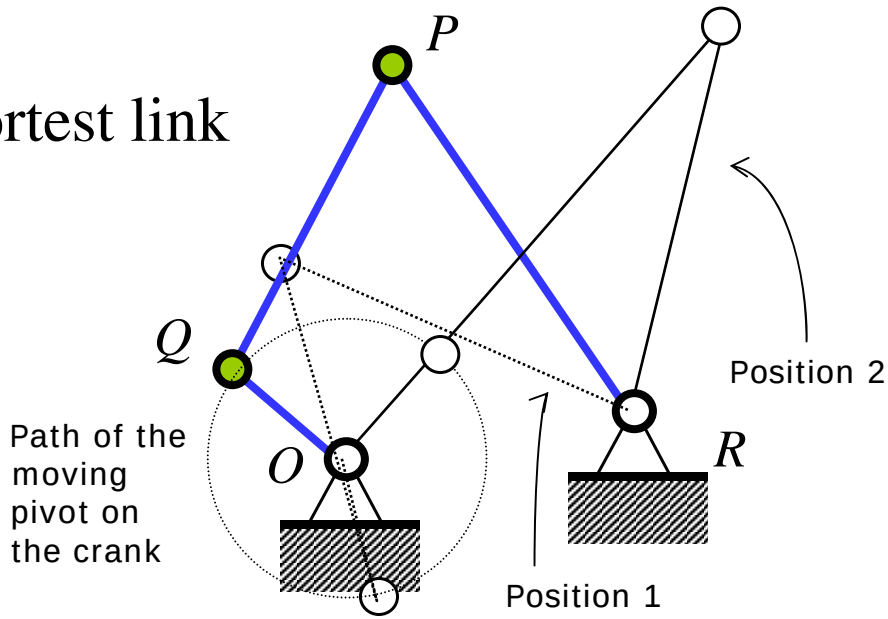

1
s
2
q
l
4
p
3


q
2
1
p
l
3
4
s

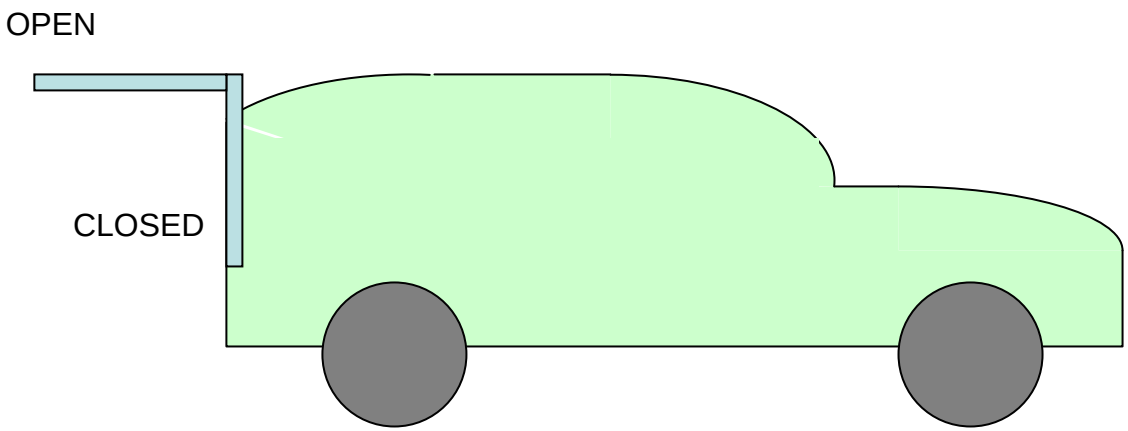
Crank Rocker

$$s + l < p + q$$

Crank is the shortest link

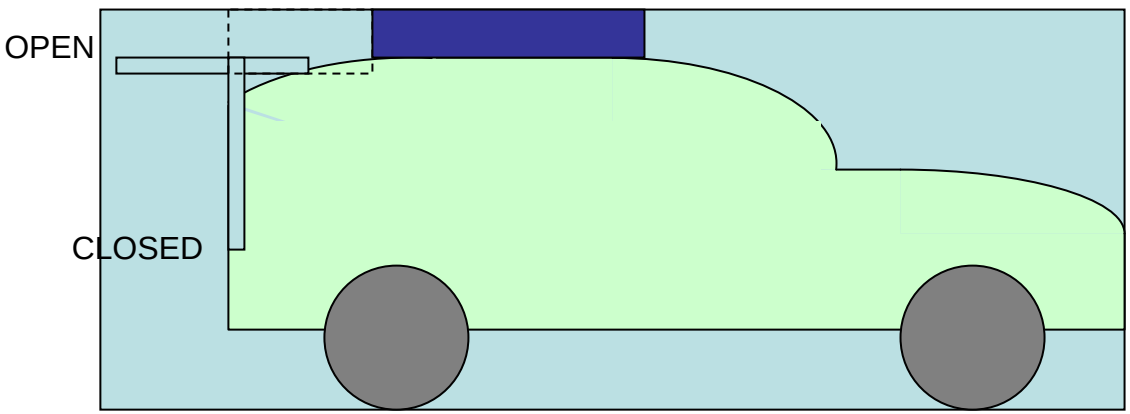


Synthesis



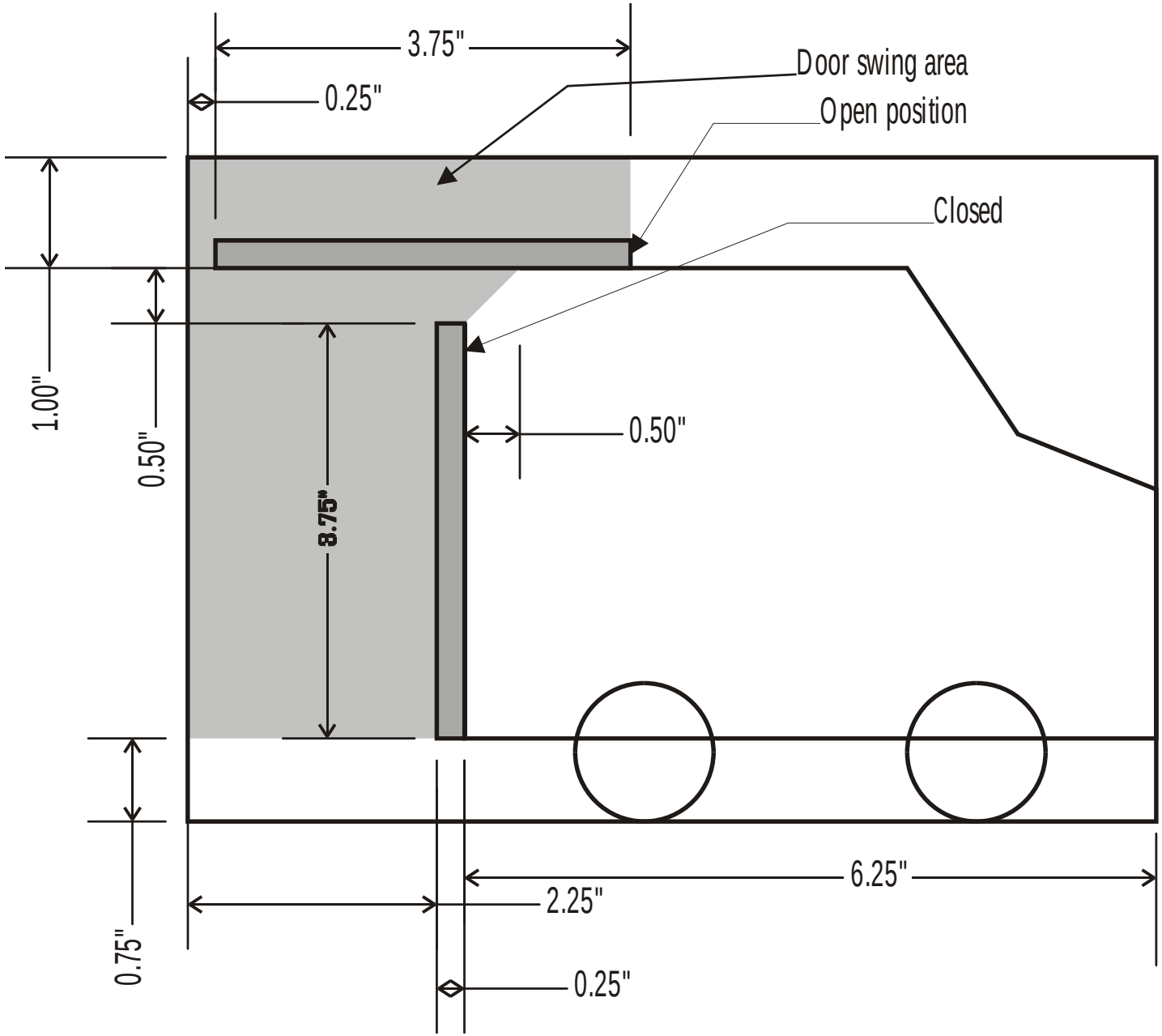
PROBLEM

DOOR IN OLD DESIGN
SWINGS OUT



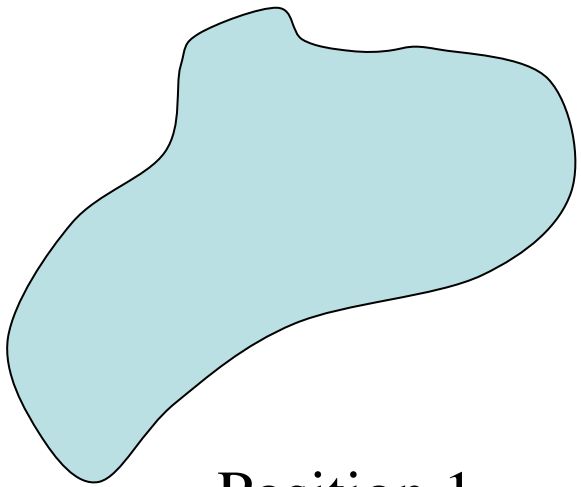
NEED

DOOR IN NEW DESIGN
SWINGS OUT 40% LESS

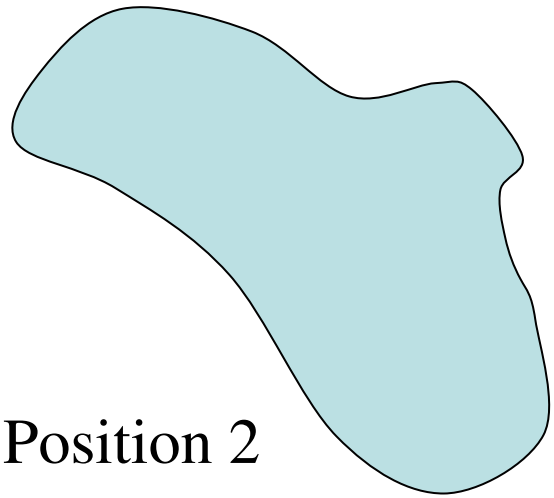

3.75"
0.25"
Door swing area
Open position
Closed
1.00"
0.50"
8.75"
0.50"
0.75"
2.25"
6.25"
0.25"

Two-Position Synthesis of Linkages

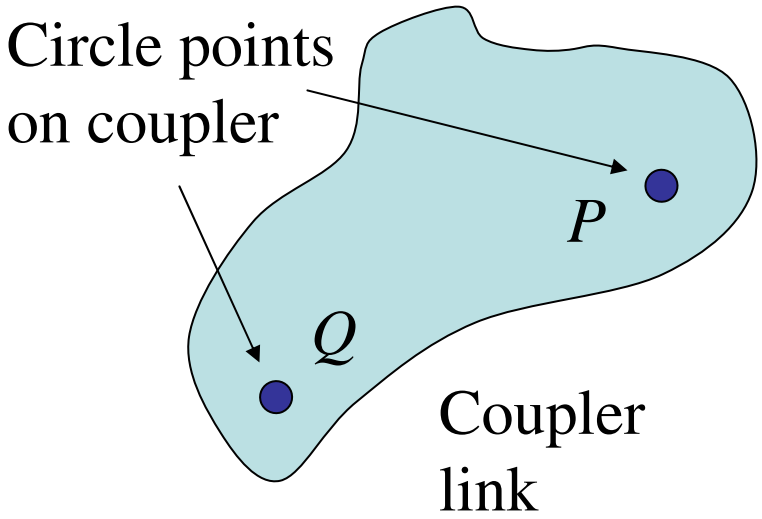
Find a four bar linkage whose coupler, when attached to a specified rigid body, guides the rigid body between two given positions (and orientations).

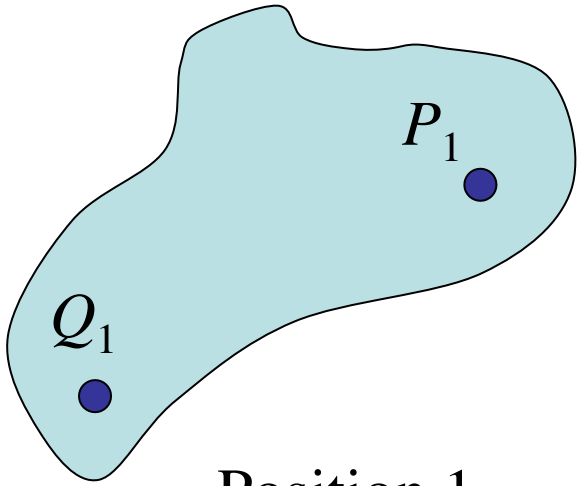


Position 1

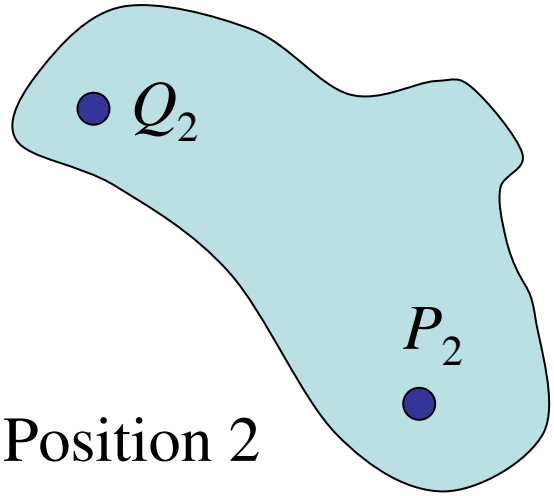


Position 2

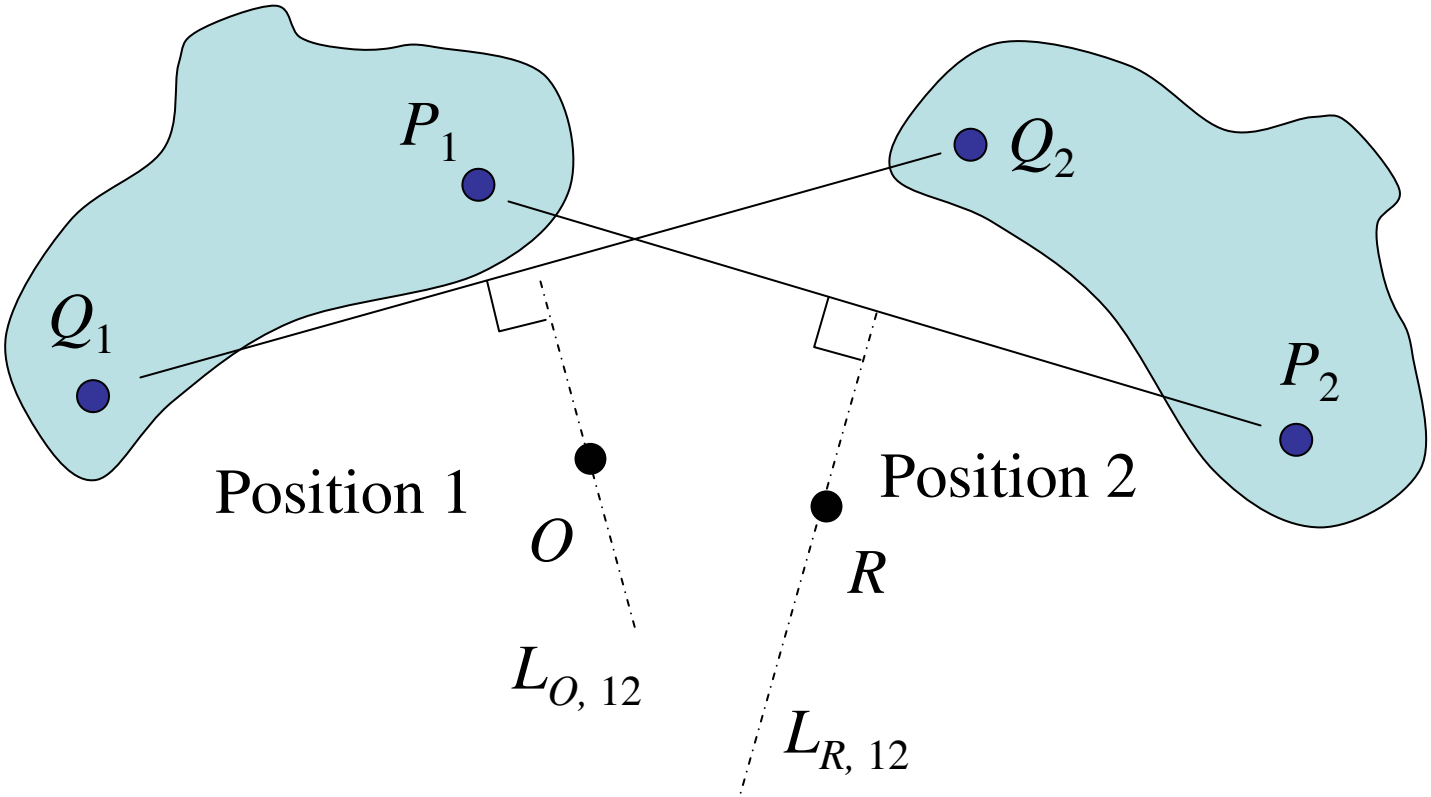

Circle points
on coupler
P
Q
Coupler
link

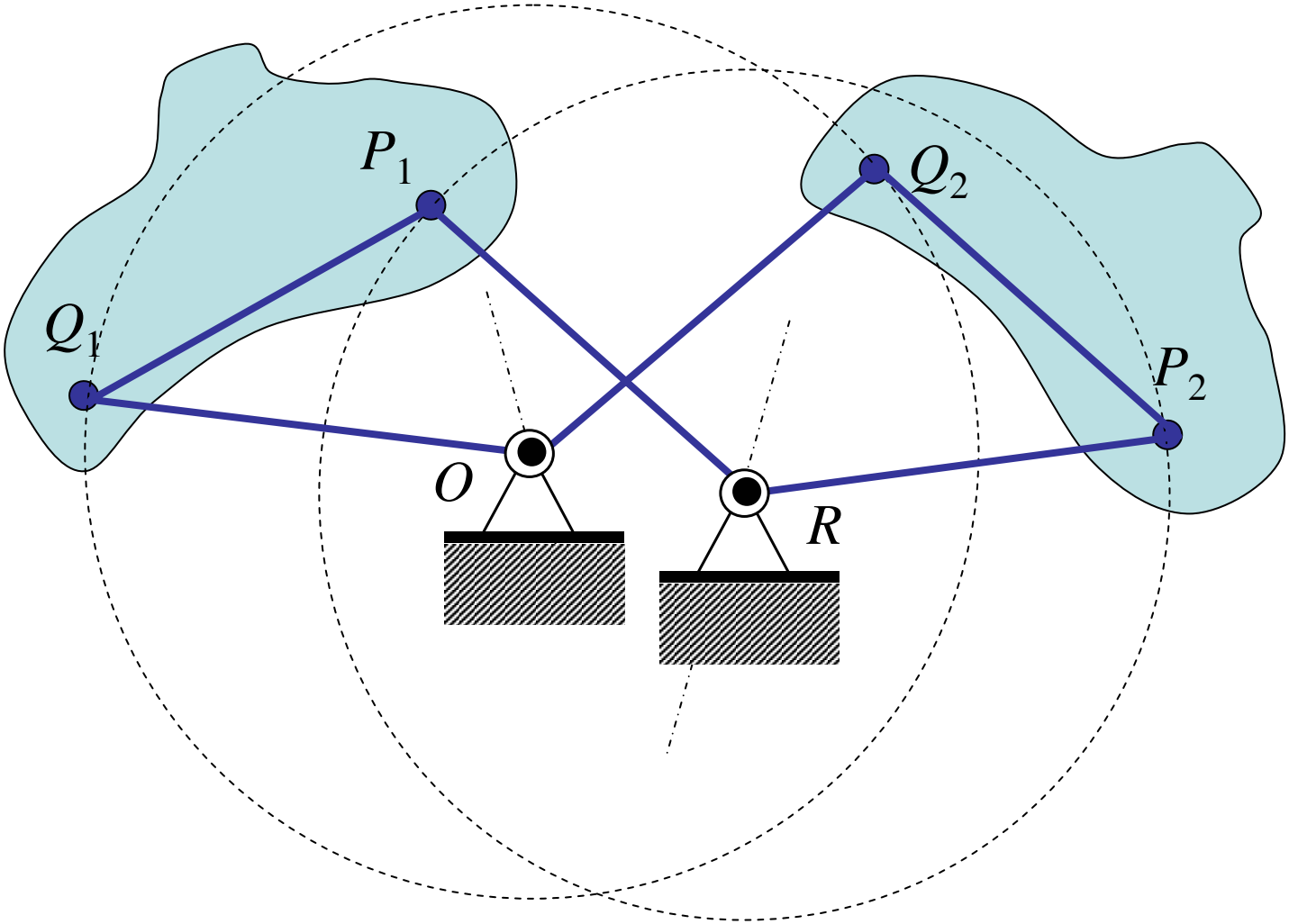


Position 1

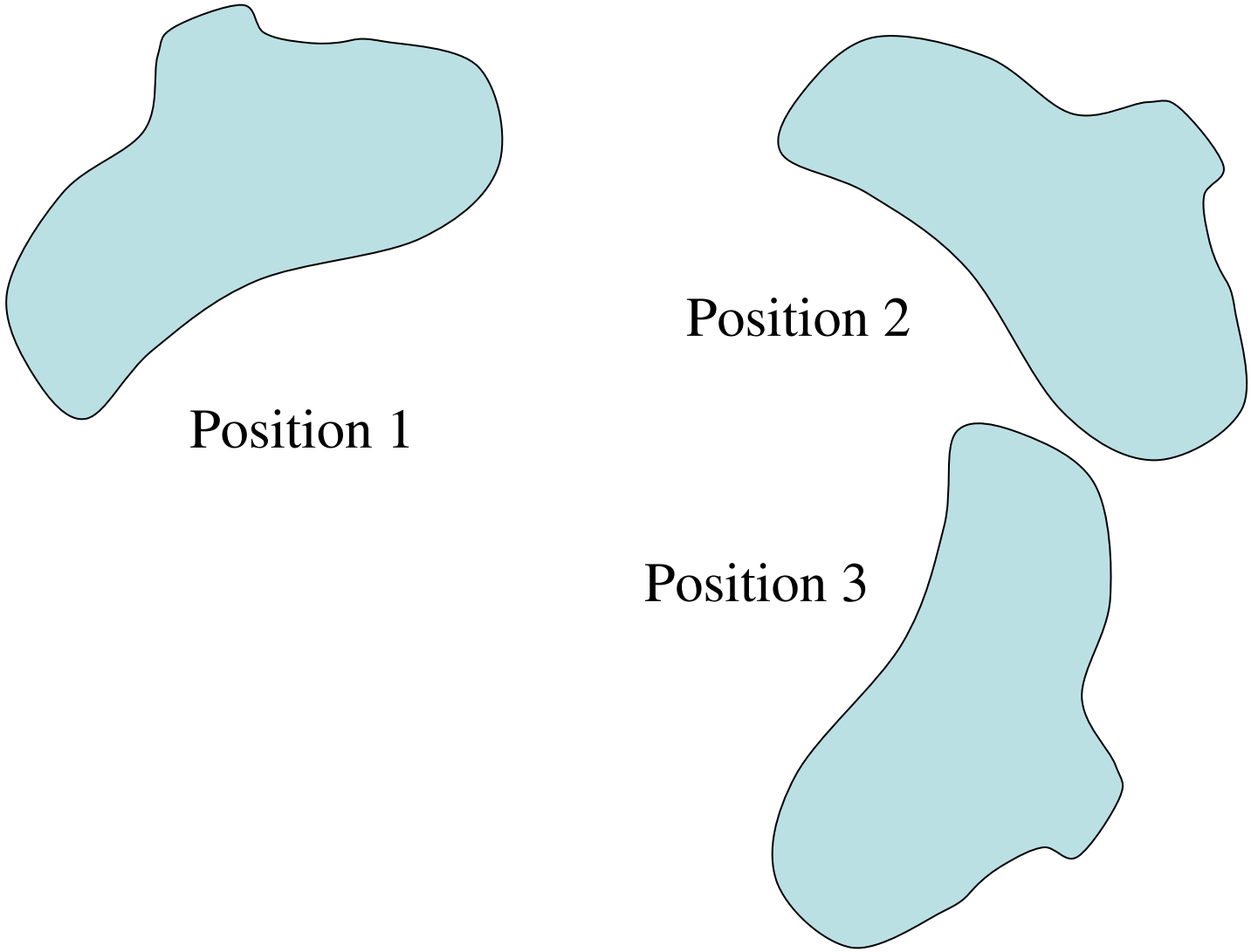


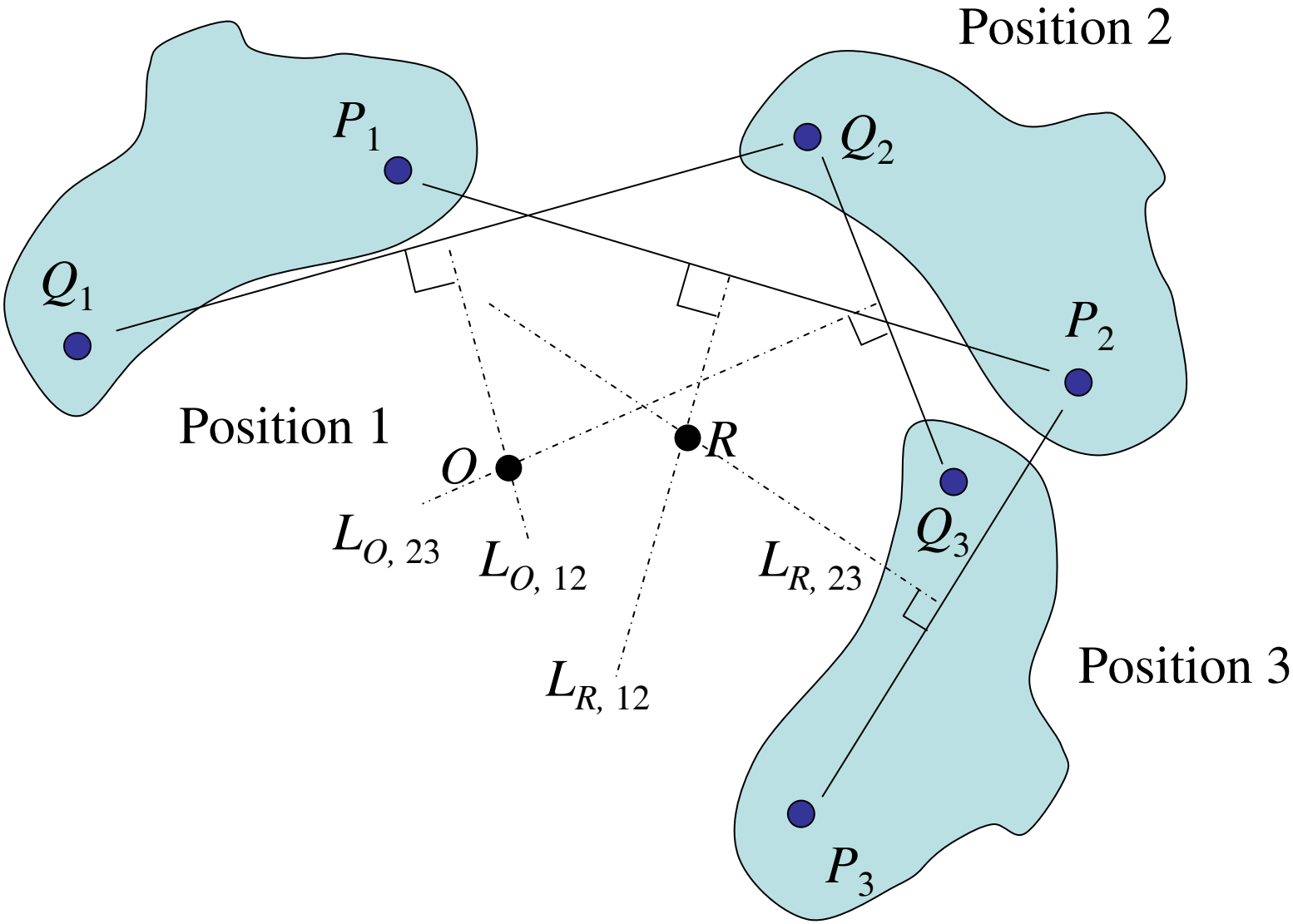
Position 2

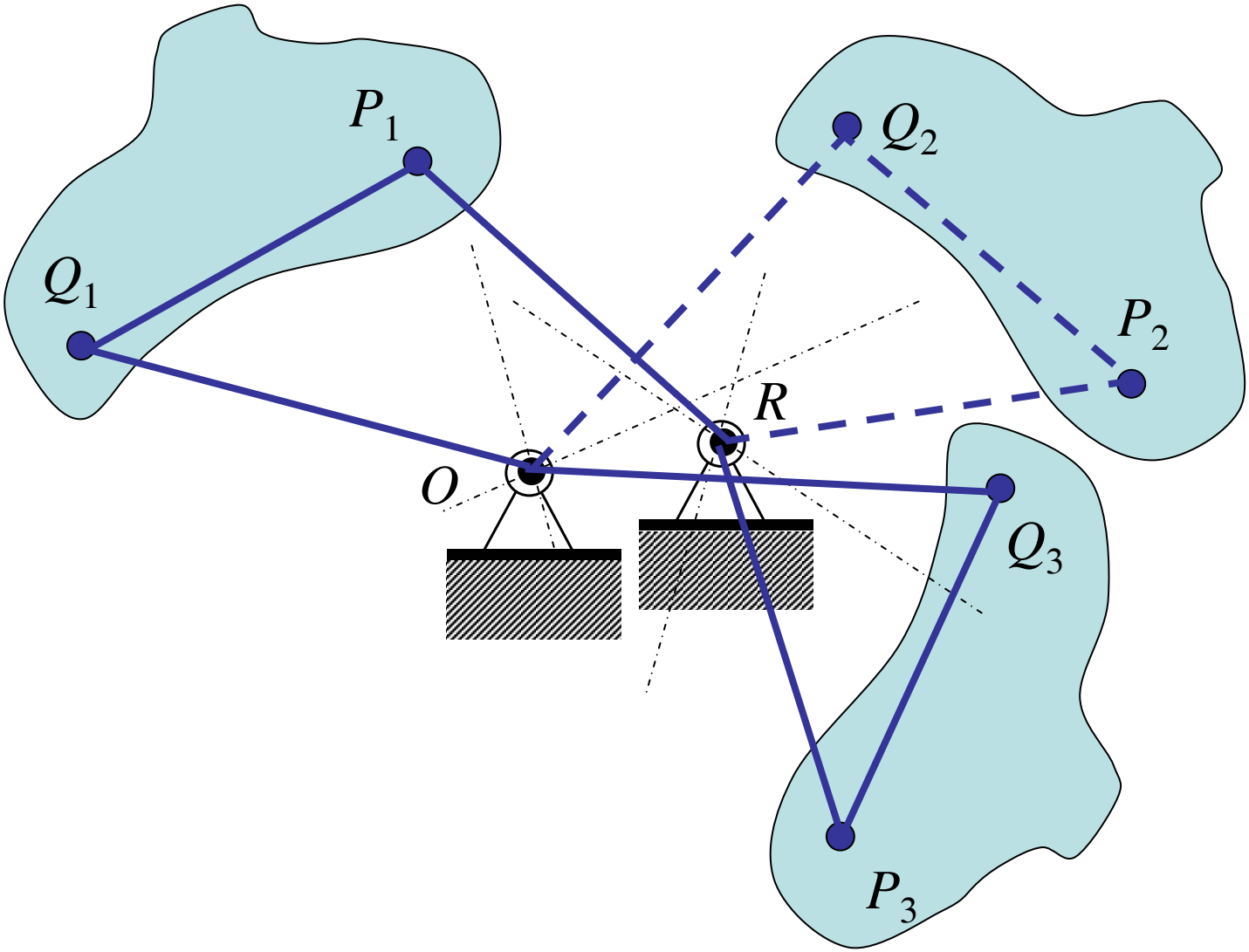

P_1
Q_2
Q_1
P_2
Position 1
Position 2
O
R
$L_{O,\,12}$
$L_{R,\,12}$


P_1
Q_2
Q_1
P_2
O
R

Three-Position Synthesis of Linkages




Position 2
P_1
Q_2
Q_1
P_2
Position 1
O
R
$L_{O,\,23}$
$L_{O,\,12}$
$L_{R,\,23}$
Q_3
$L_{R,\,12}$
Position 3
P_3


P_1
Q_1
Q_2
P_2
R
O
Q_3
P_3