



The background is a green-tinted technical drawing. It features a central wireframe profile of a human head facing left. Surrounding the head are various mechanical and technical diagrams. On the left, there's a circular component with dimensions like 120, 80, 60, 55, 10, and 20. Above the head, there's a small airplane icon and text: "Hyper Human Technology" and "Series new model towards 21st century". To the right of the head, there's a radiation symbol icon and text: "120452001--super H Technology" and "Series new model towards 21st century". Below the head, there's a rectangular component with dimensions like 400, 370, 140, and 140. The overall theme is a blend of human anatomy and mechanical engineering.

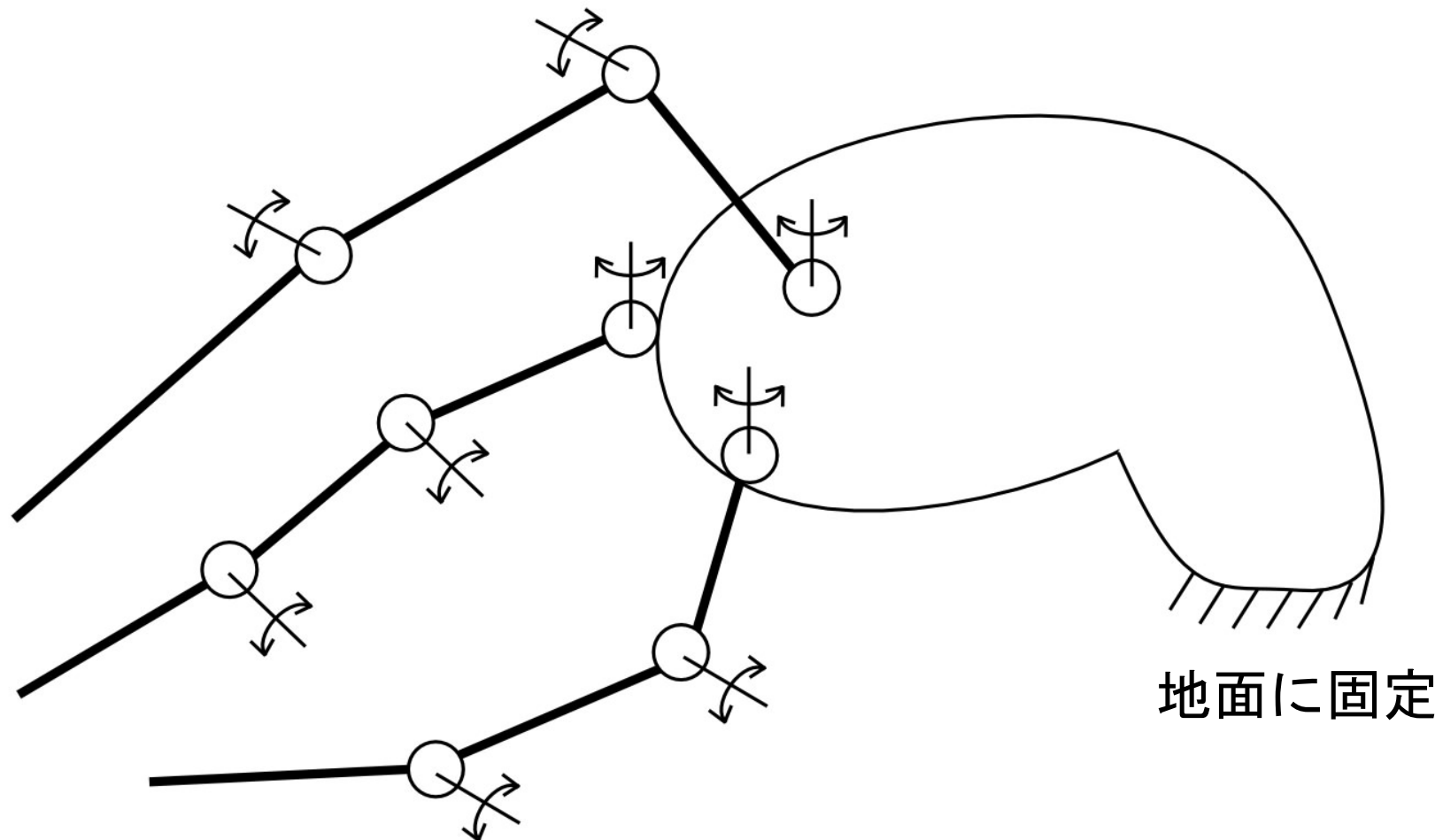
機構学

Part3: 機構の自由度

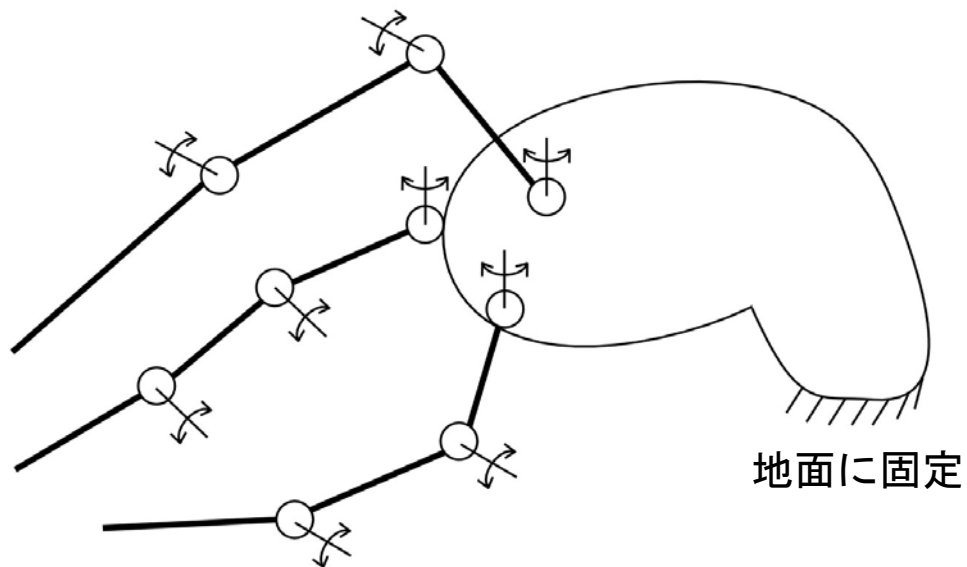
金子真

課題 1

機構の自由度は？



課題 1 の答え



$$N = 10$$

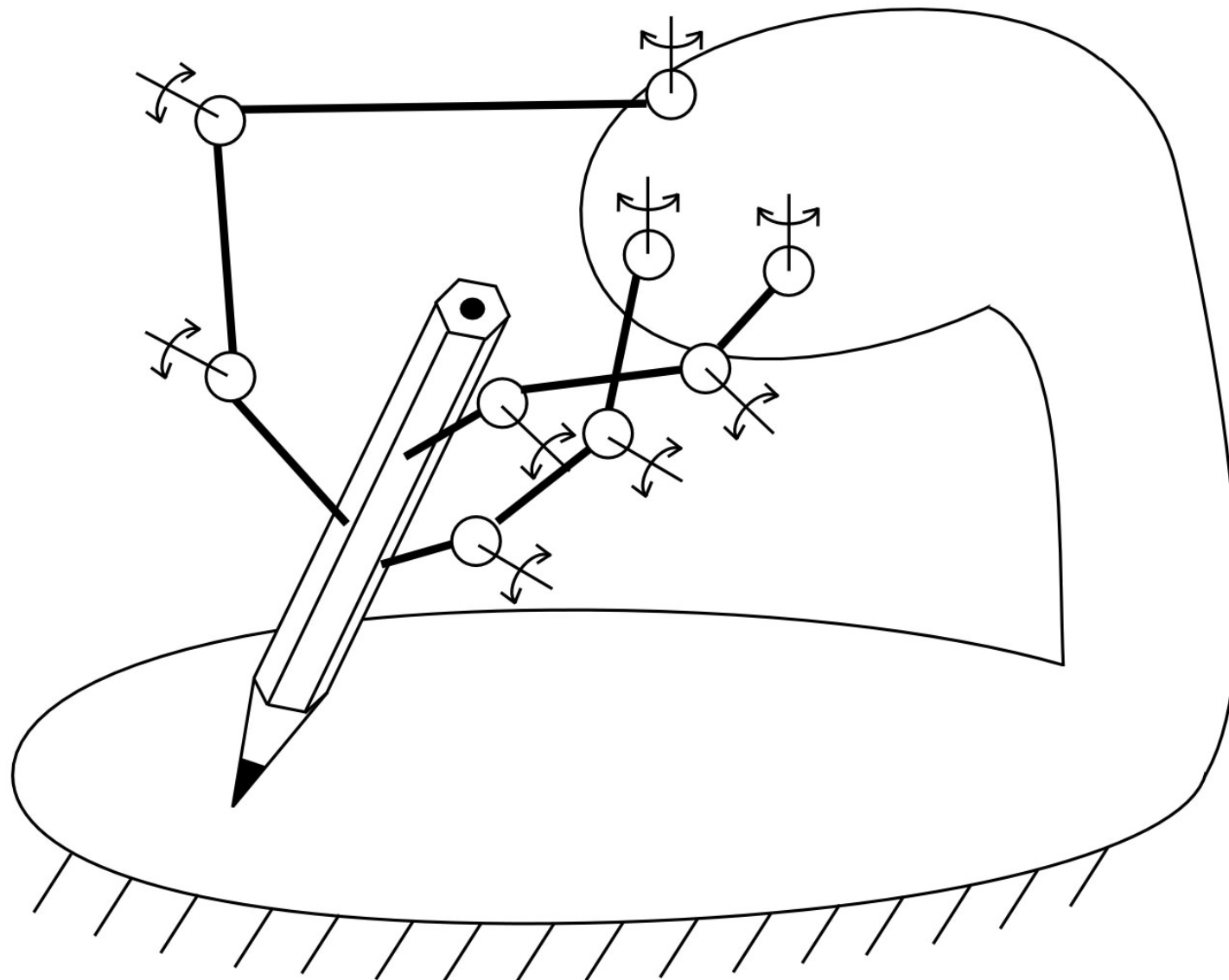
$$J = 9$$

$$\sum f_i = 9$$

$$F = 6(N - J - 1) + \sum f_i$$
$$= 9$$

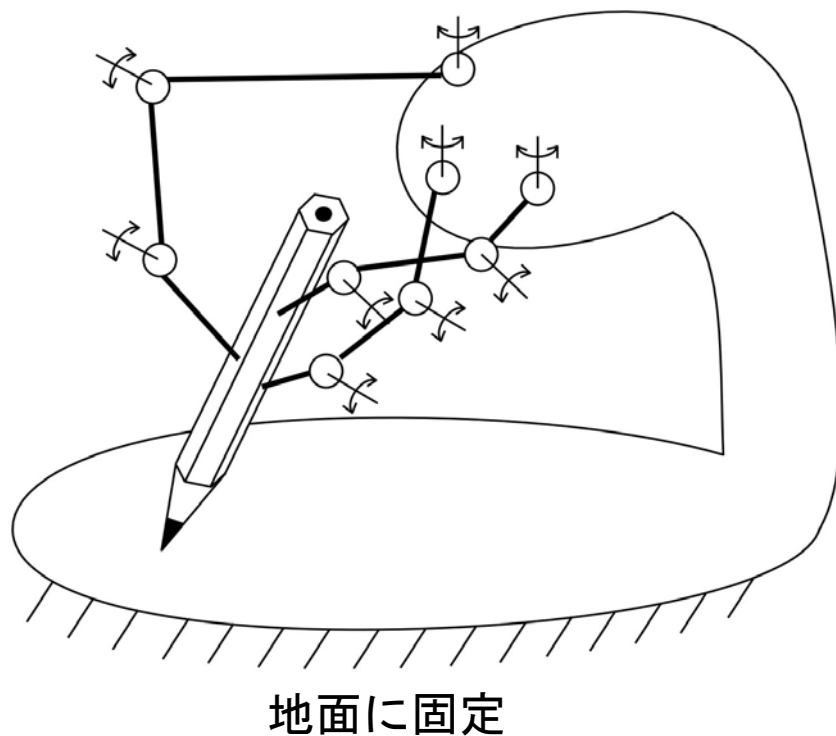
課題 2

機構の自由度は？



地面に固定

課題 3 の答え



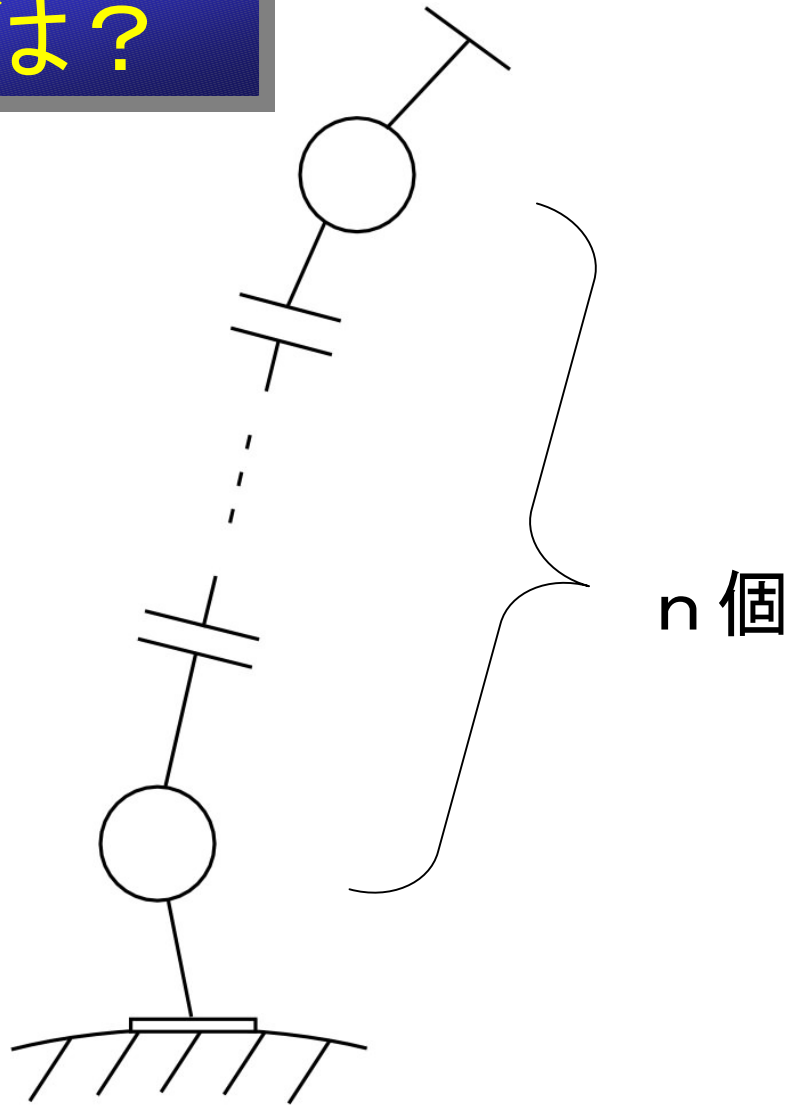
$$N = 11$$

$$J = 13$$

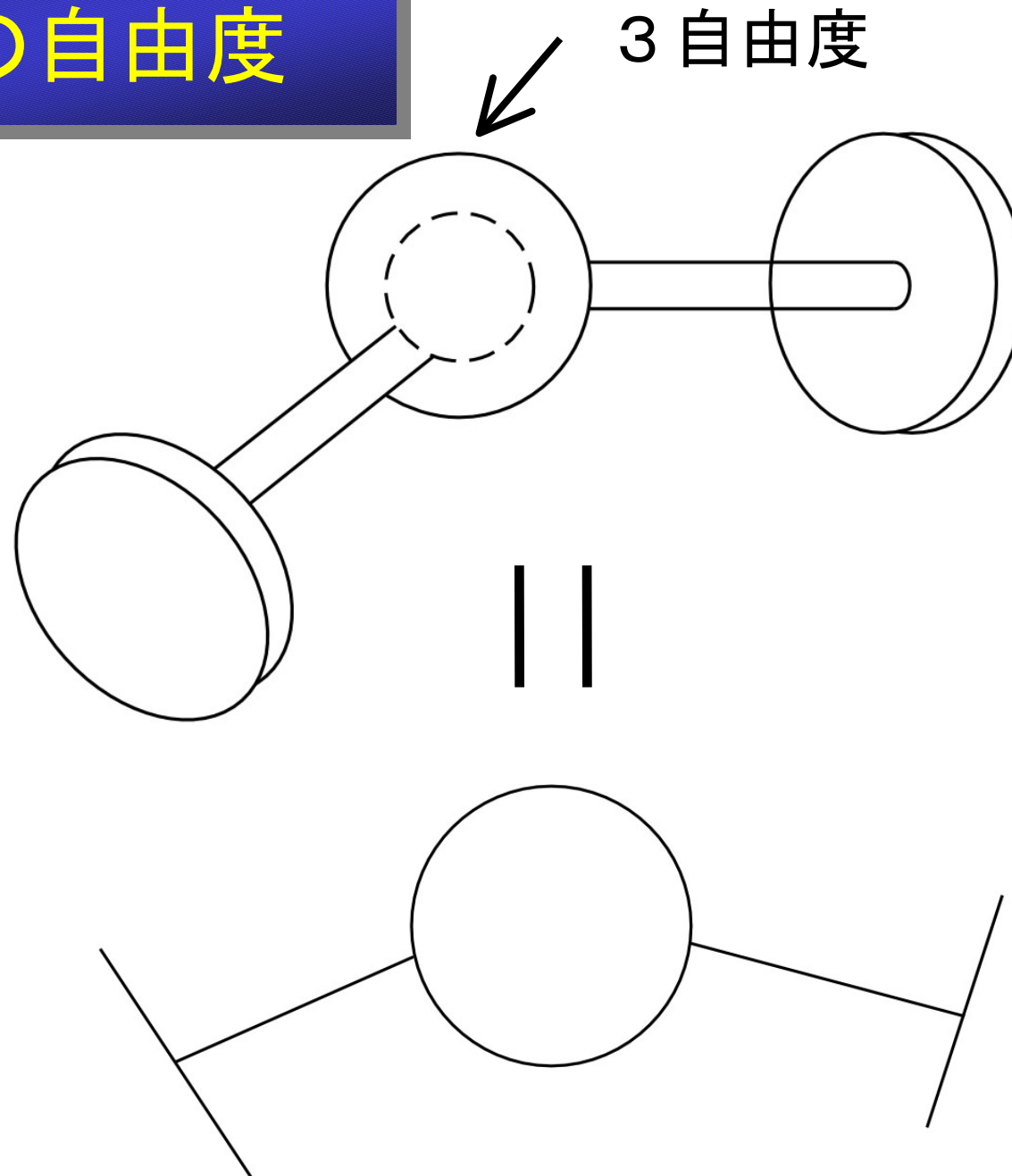
$$\sum f_i = 9 + 3 \times 4 = 12$$

$$\begin{aligned} F &= 6(N - J - 1) + \sum f_i \\ &= 3 \end{aligned}$$

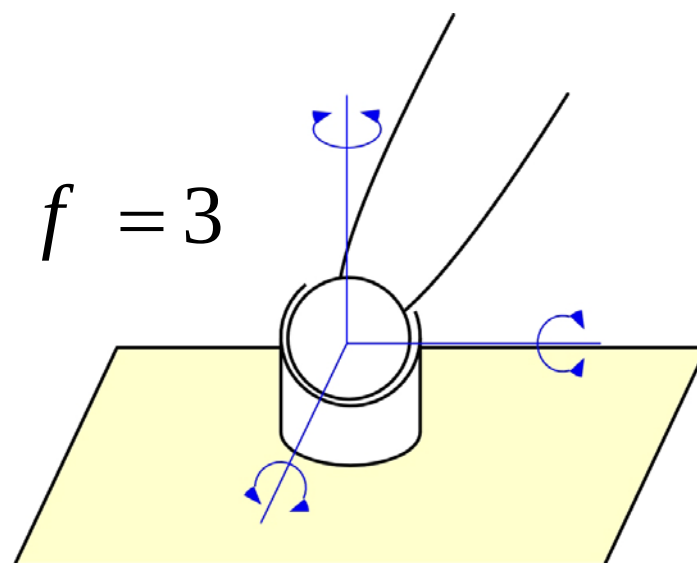
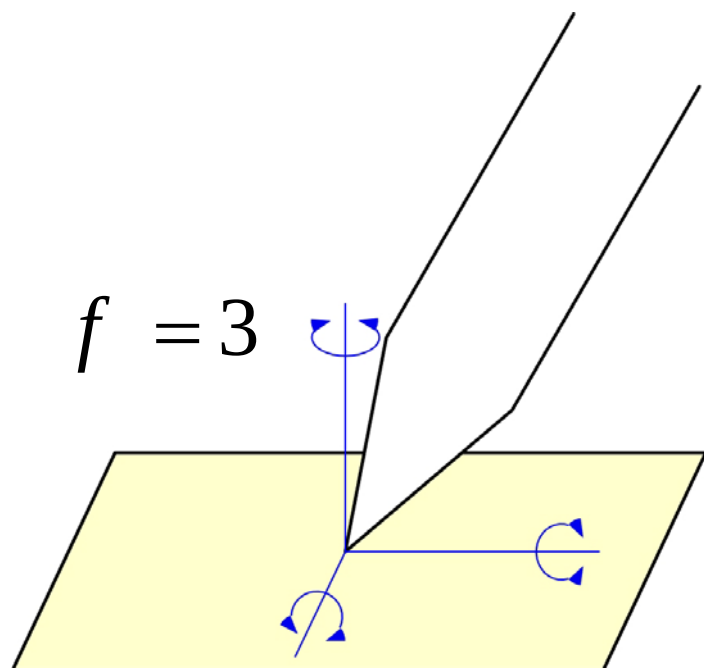
課題1: 球関節が n 個 連なったらFkは?



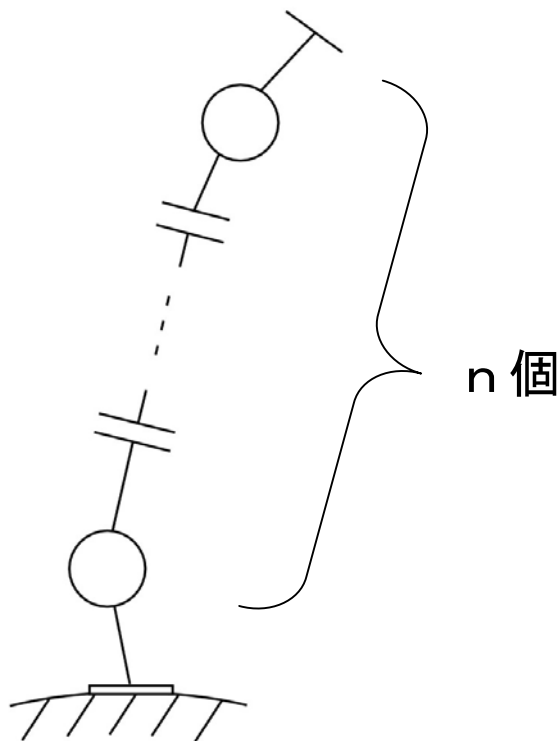
球関節の自由度



ロボットの足先と地面との自由度



課題0の答え



$$N = n + 1$$

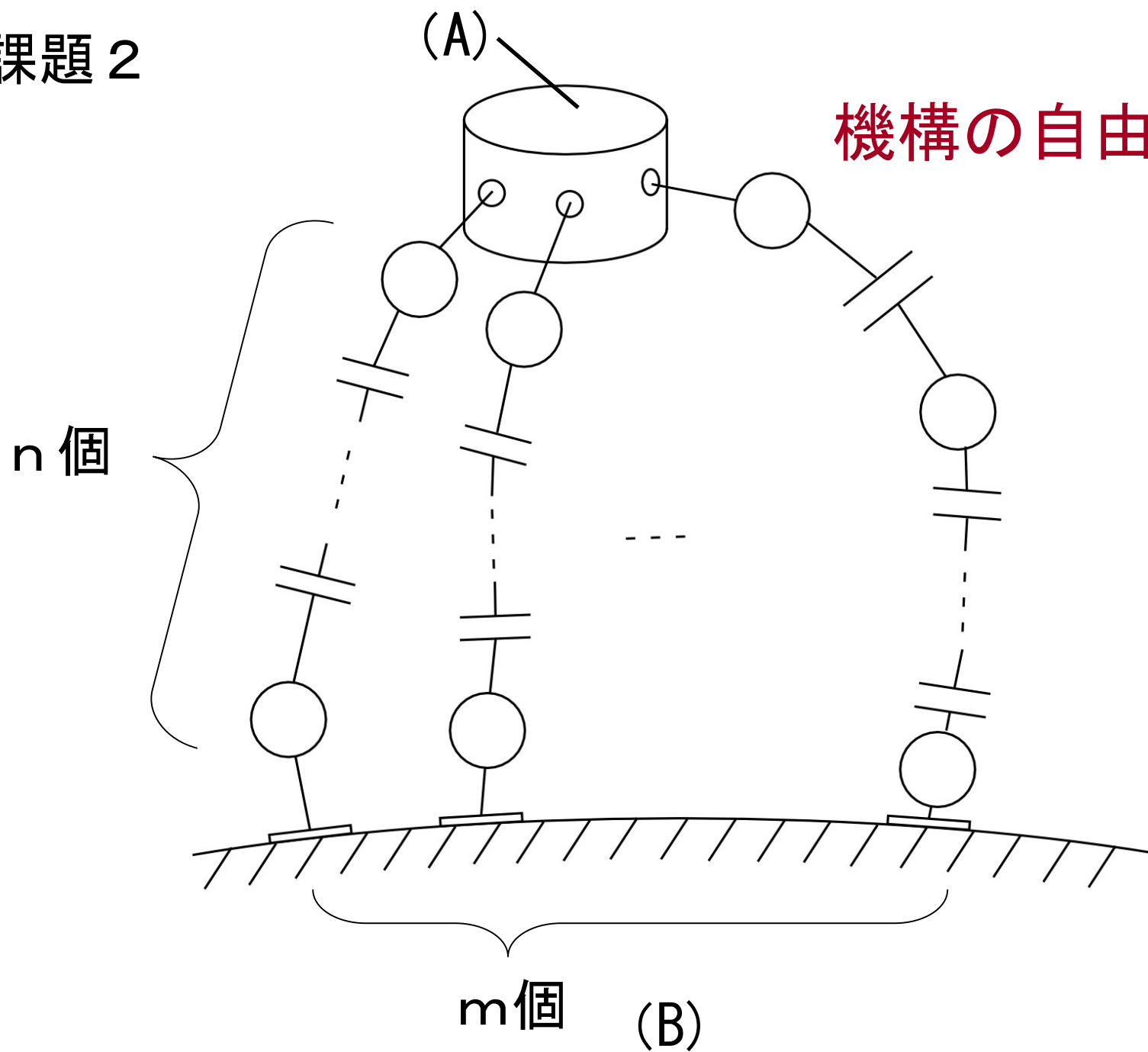
$$J = n$$

$$\sum f_i = 3 \times n$$

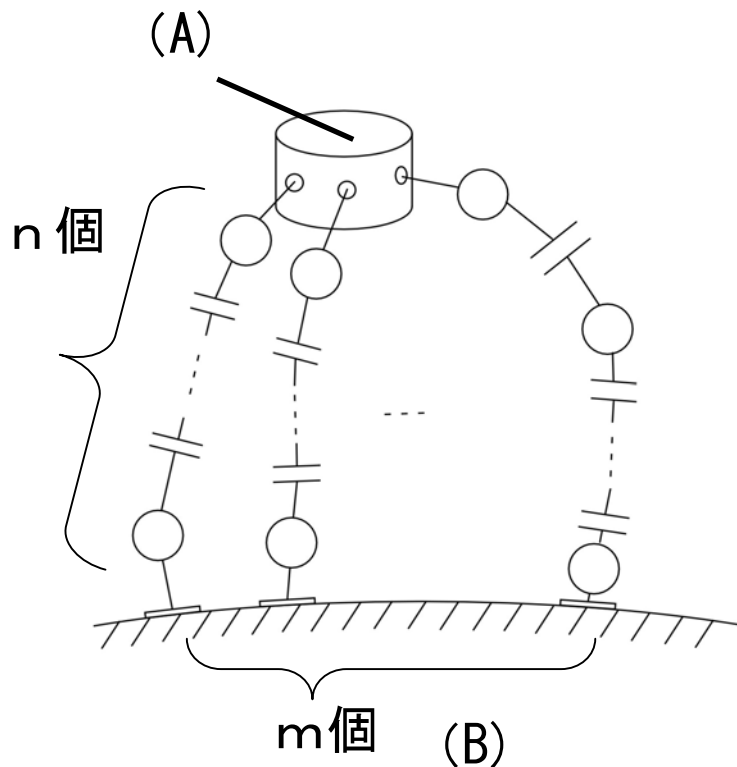
$$F = 6(N - J - 1) + \sum f_i = 3n$$

課題 2

機構の自由度は？



課題 2 の答え

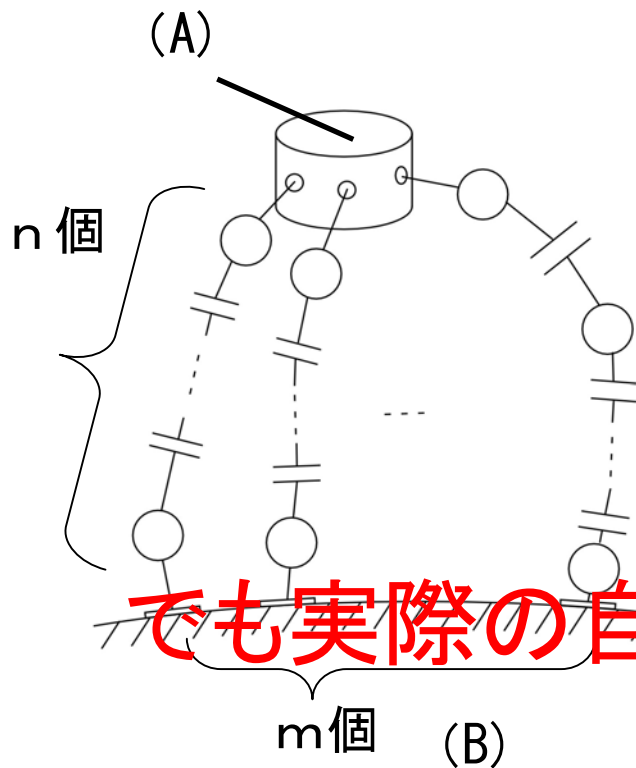


$$N = 2 + (n - 1)m$$

$$J = n \times m$$

$$\begin{aligned}
 F &= 6(N - J - 1) + \sum f_i \\
 &= 6\{2 + (n - 1)m - nm - 1\} + 3mn \\
 &= 6 - 6m + 3mn
 \end{aligned}$$

課題 2 の答え



$$\left. \begin{array}{l} n = 1 \\ m = 2 \end{array} \right\} \text{ のとき}$$

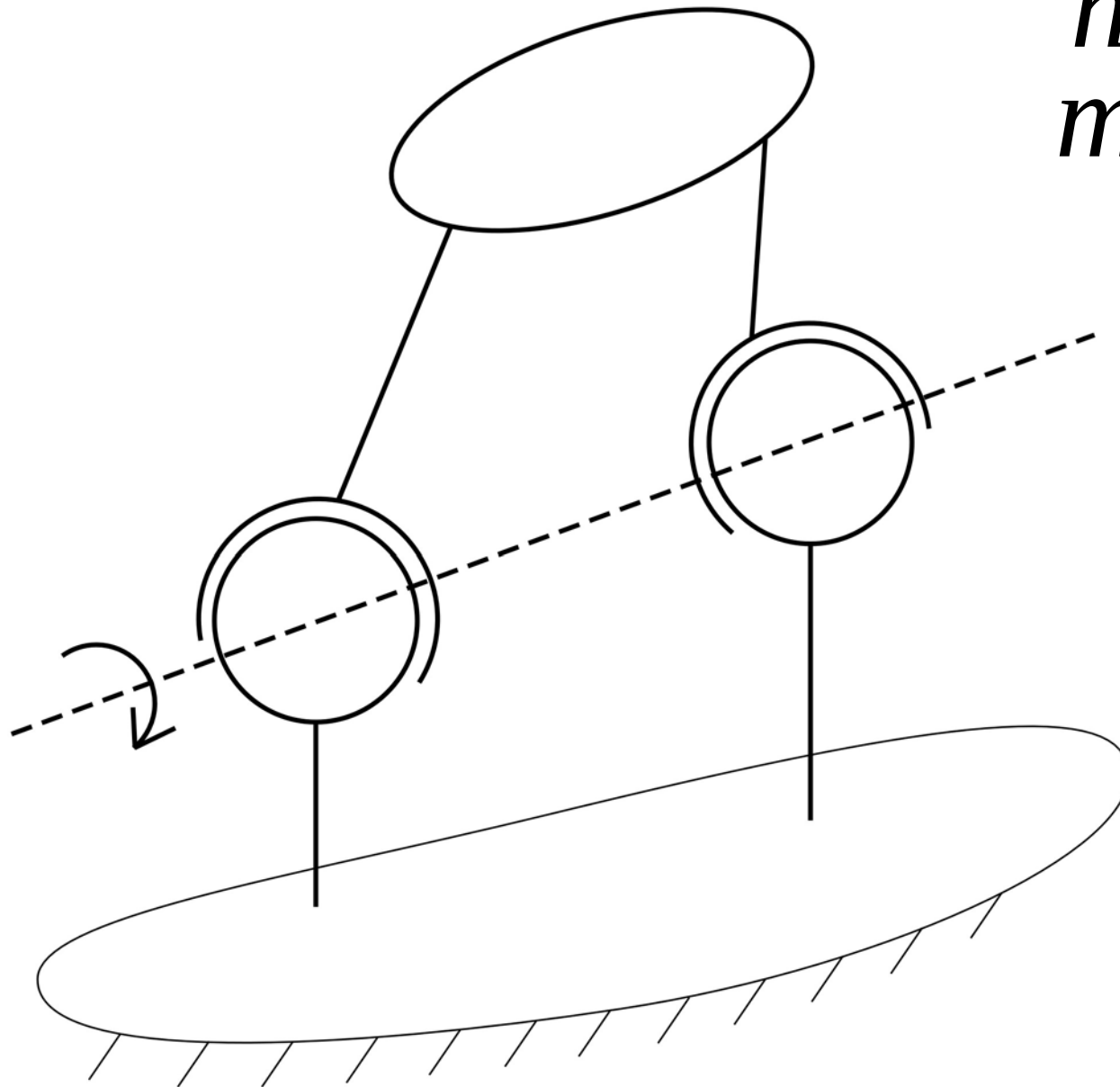
$$N = 2 + (n - 1)m = 2$$

$$J = n \times m = 2$$

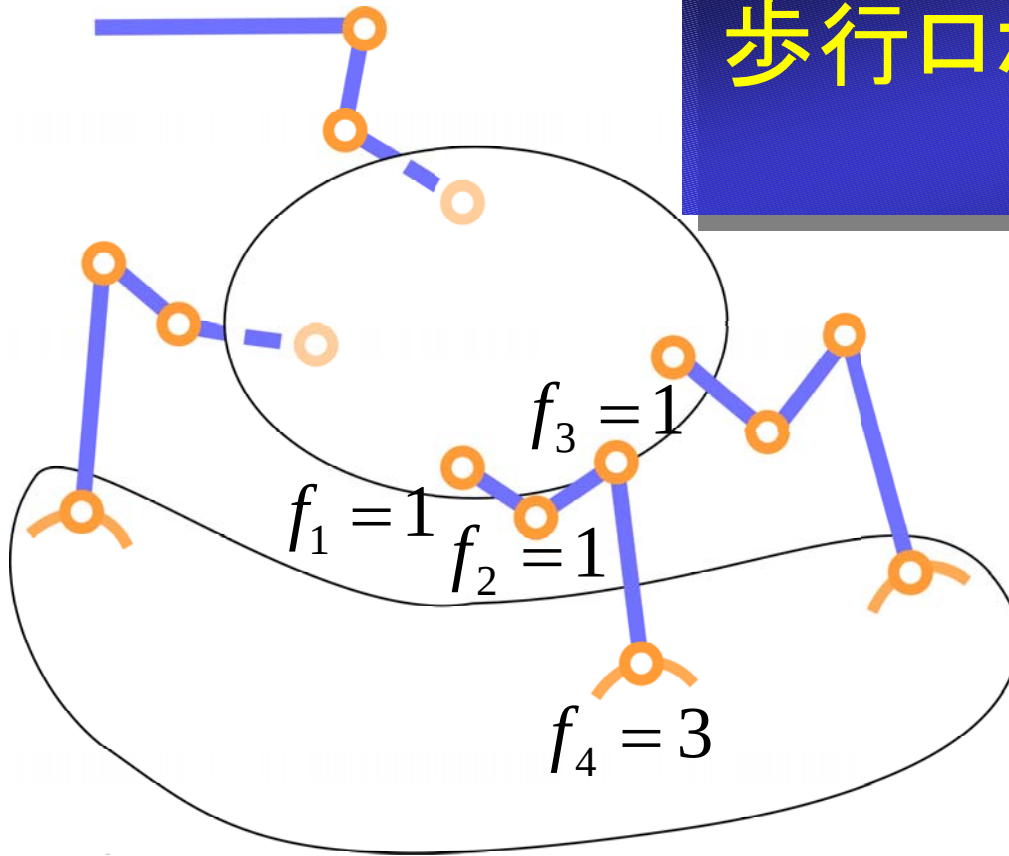
でも実際の自由度はゼロじゃない！

$$\begin{aligned} F &= 6(N - J - 1) + \sum f_i \\ &= 6(2 - 2 - 1) + 6 \\ &= 0 \end{aligned}$$

$$n = 1$$
$$m = 2$$



歩行ロボットの自由度 課題3

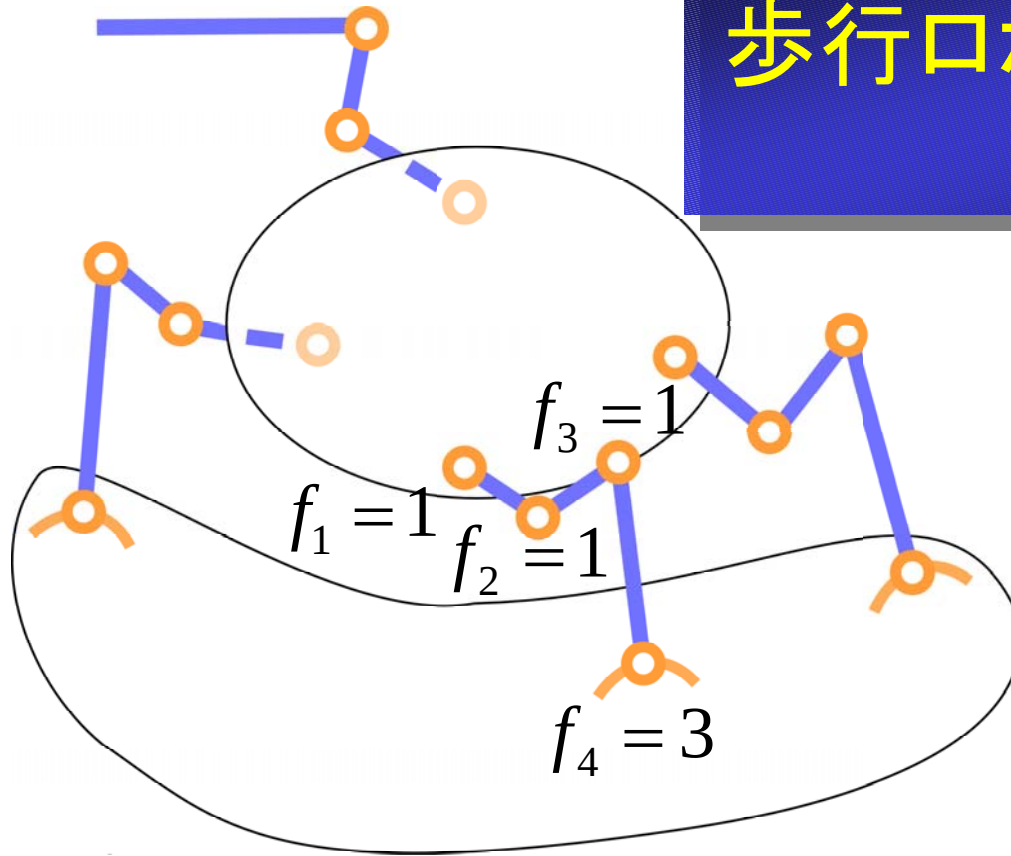


9 自由度
の意味は？

$$N = 14 \quad J = 4 \times 3 + 3 = 15$$

$$\begin{aligned} F_k &= 6 \times (14 - 15 - 1) + \sum f_i \\ &= -12 + (6 \times 3 + 3) \\ &= 9 \end{aligned}$$

歩行ロボットの自由度 課題3

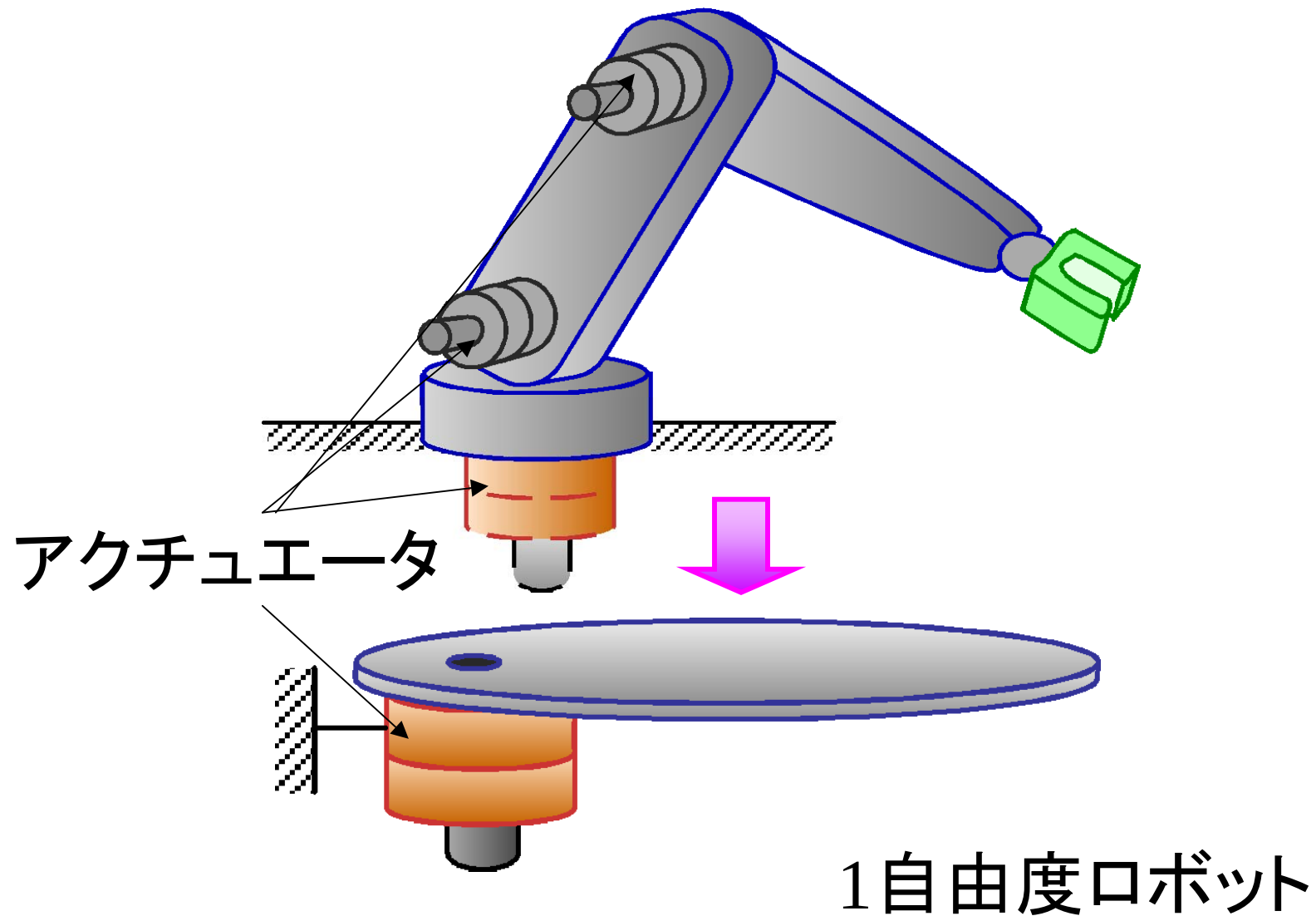


9 自由度
の意味は？

3は遊脚の自由度

6は胴体の位置(3)・姿勢(3)の自由度

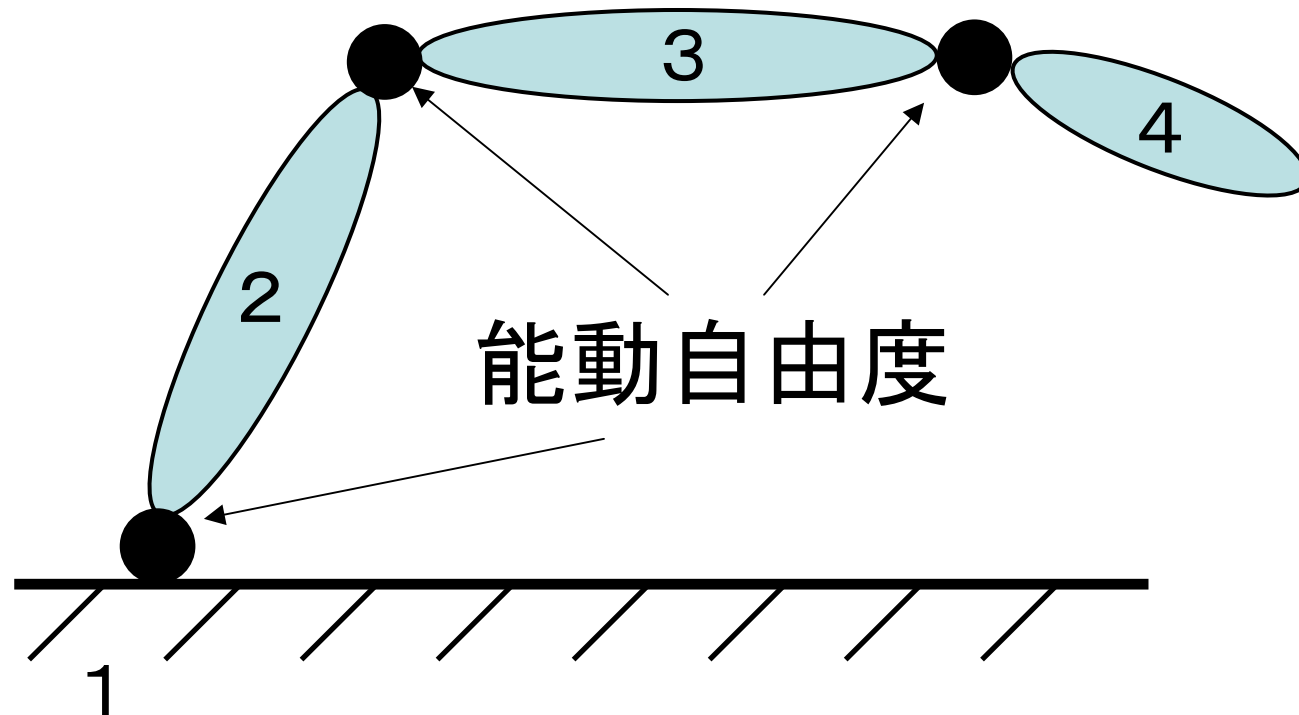
能動自由度と受動自由度



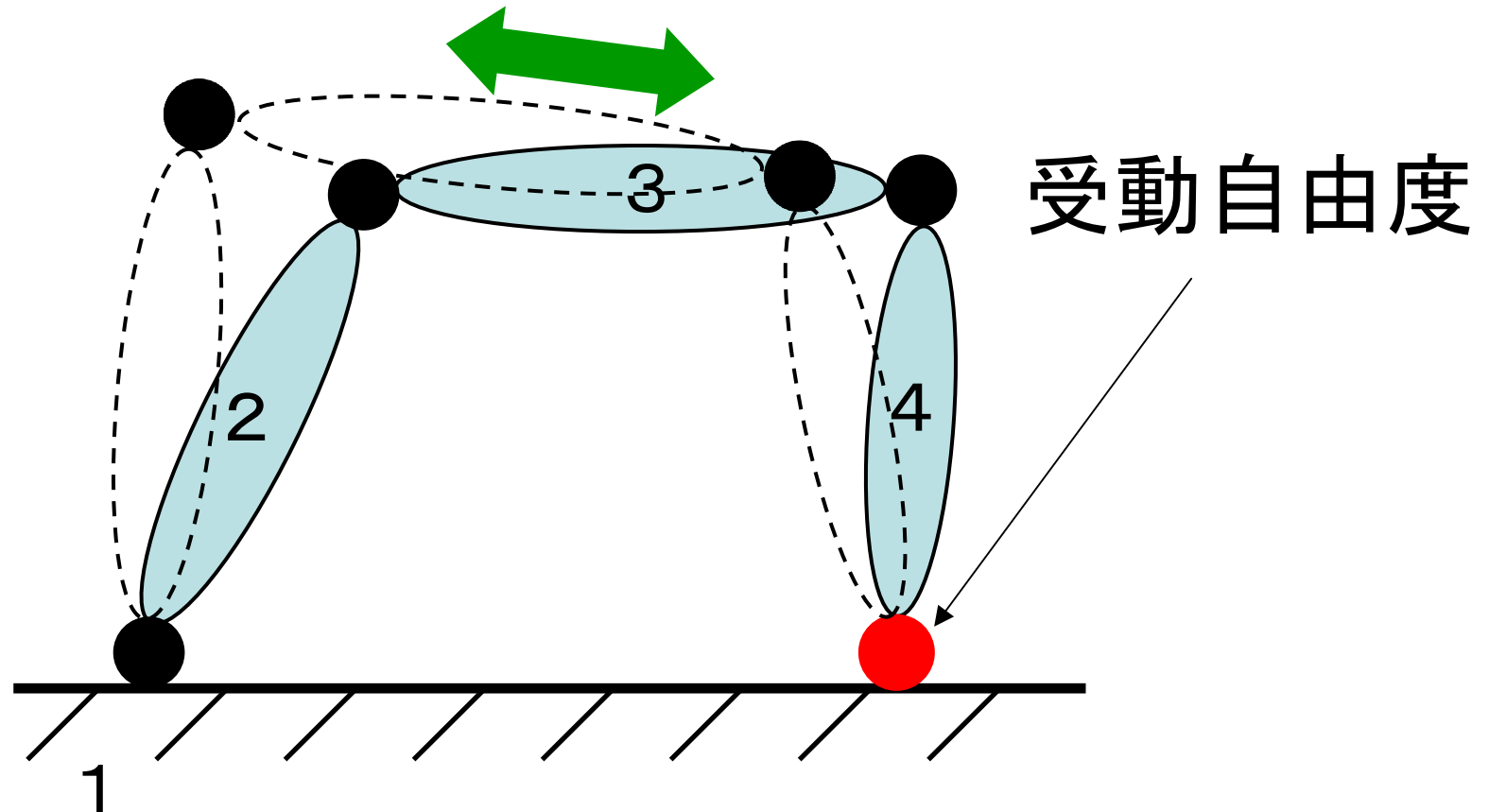
能動自由度と受動自由度

能動自由度: アクチュエータがついている

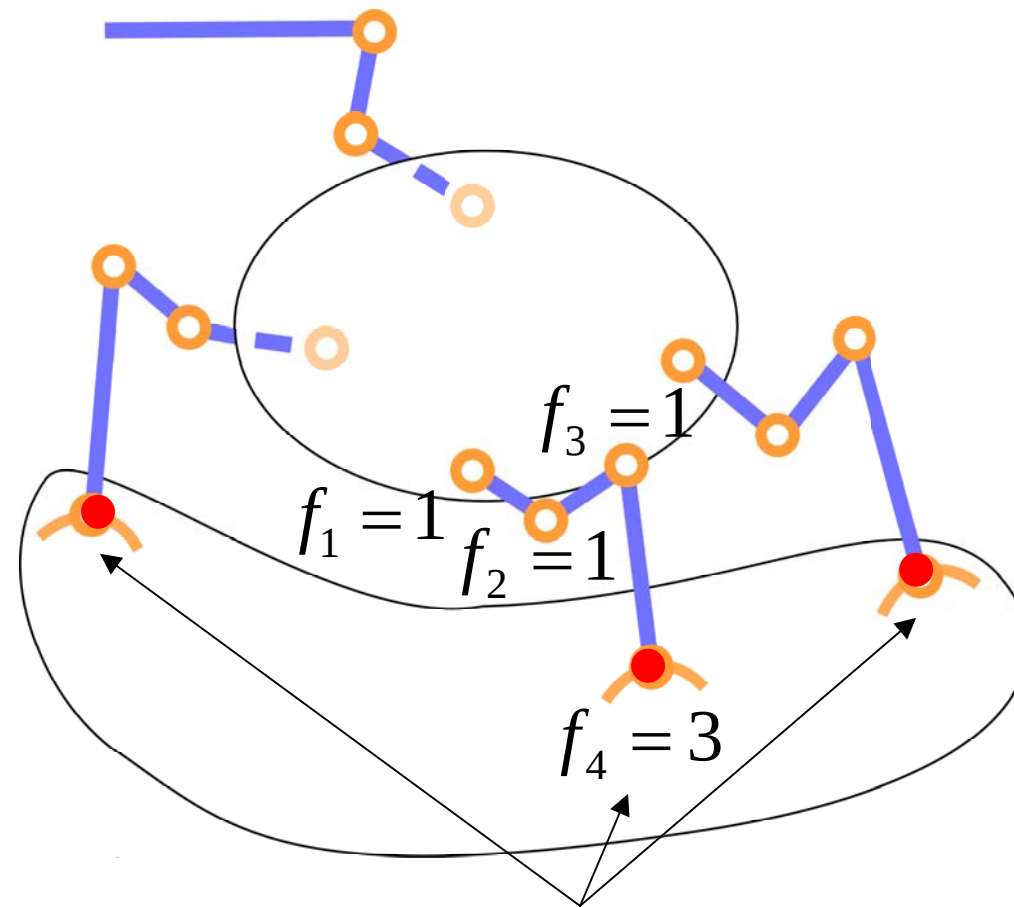
受動自由度: アクチュエータがついていない



能動自由度と受動自由度



能動自由度と受動自由度

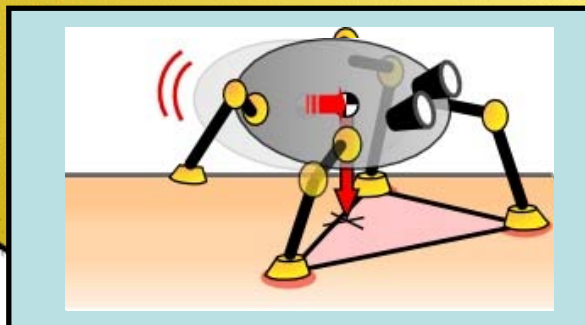


受動自由度

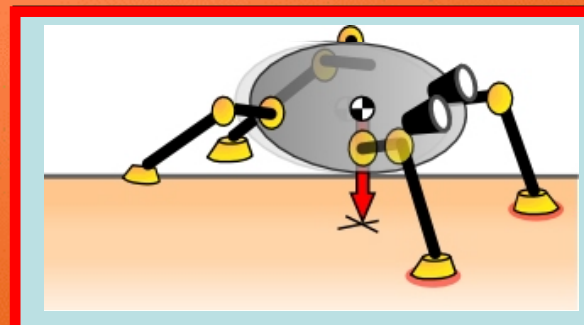
脚式・歩行ロボット

跳躍ロボット

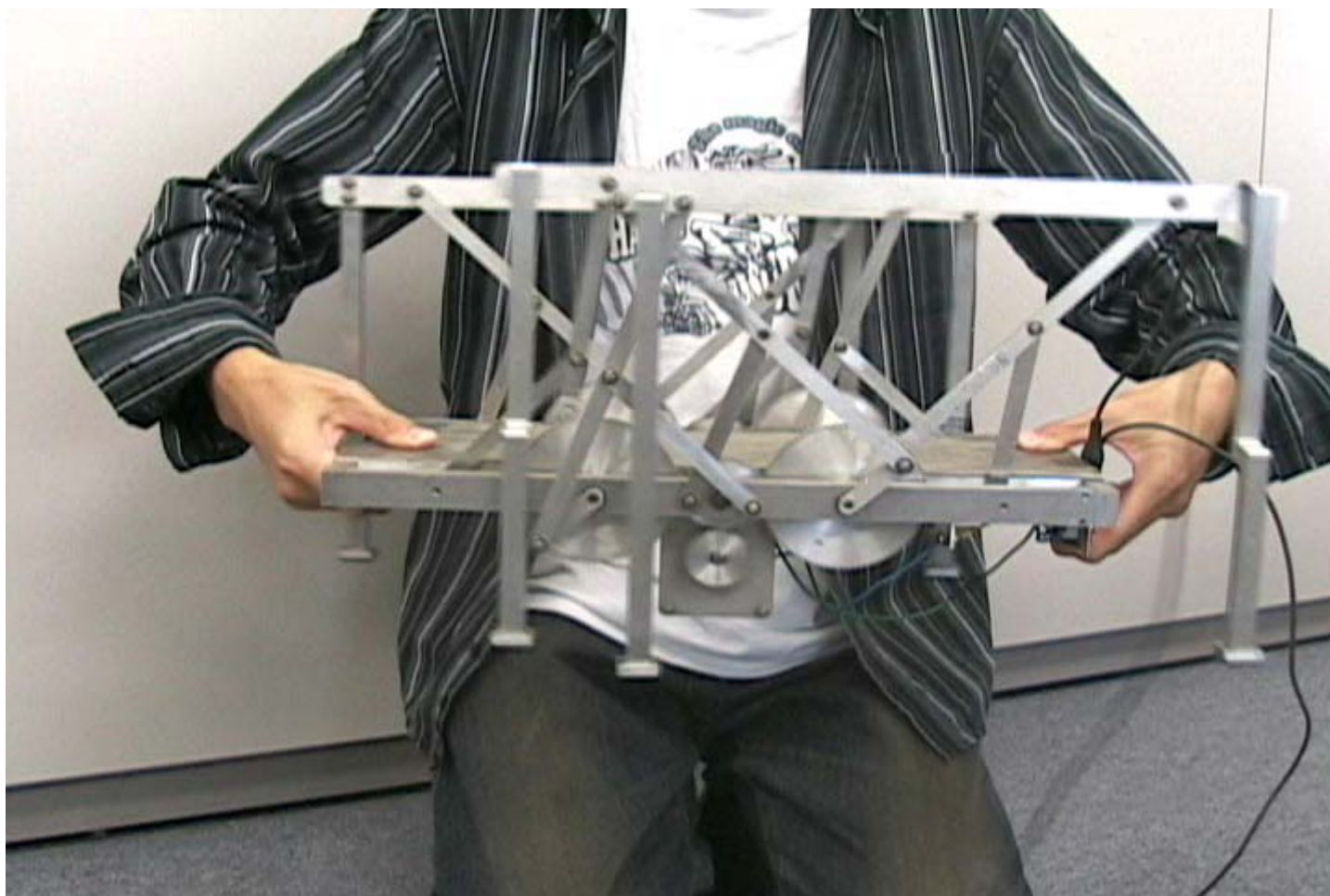
静的歩行



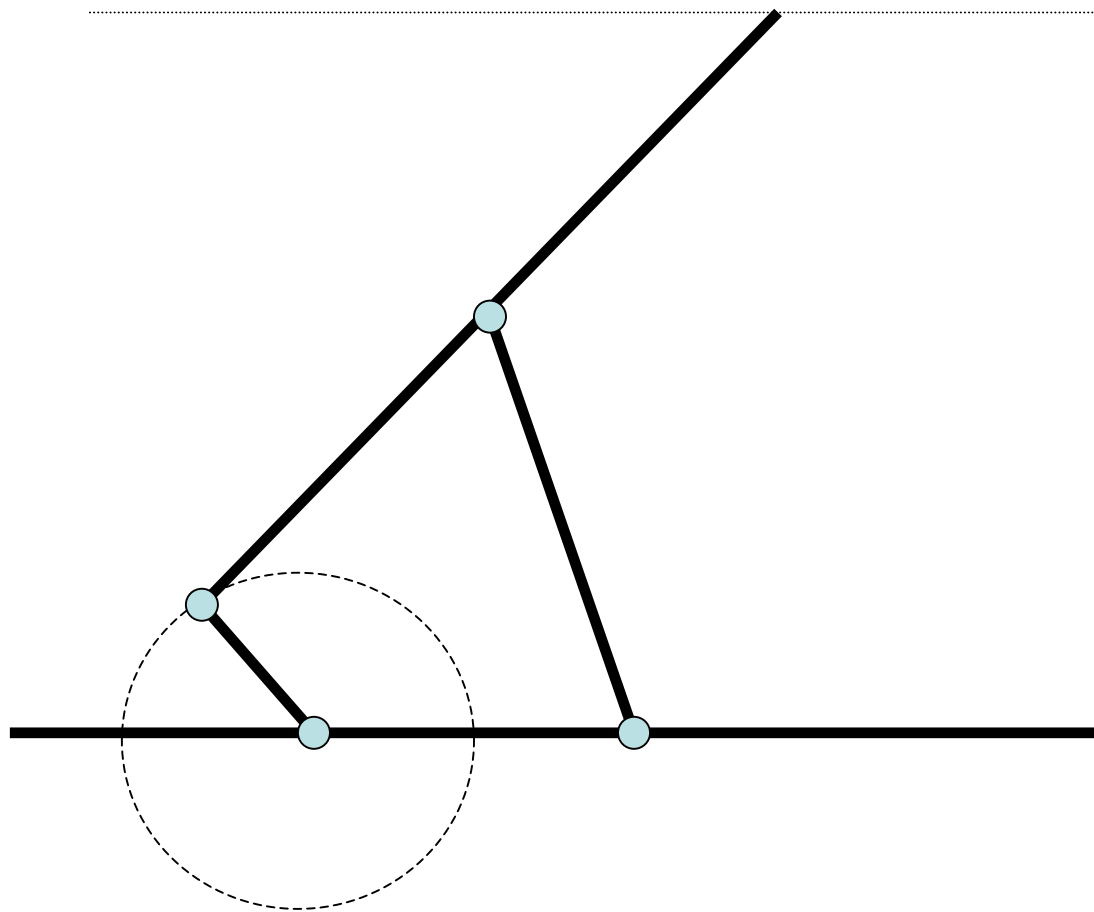
動的歩行

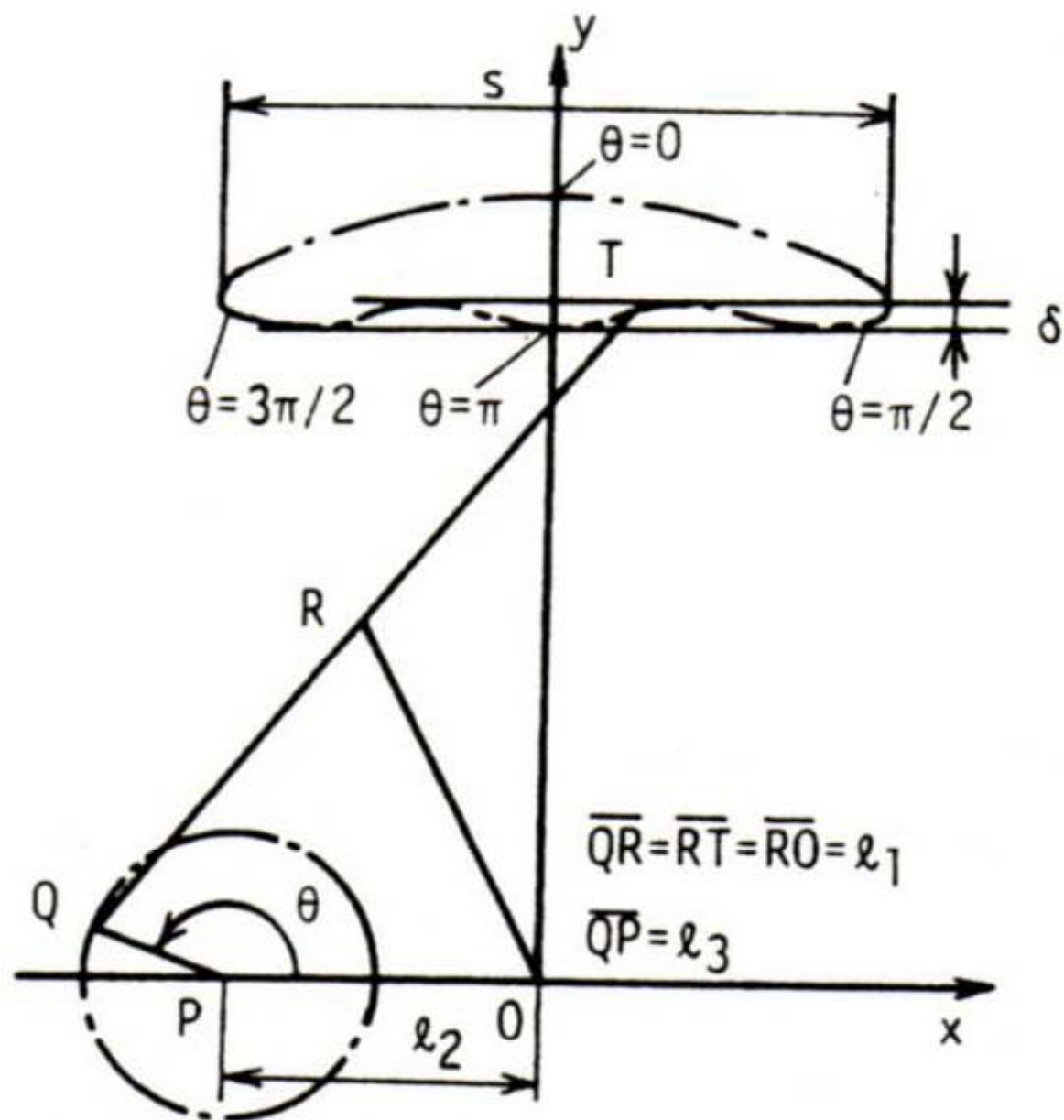


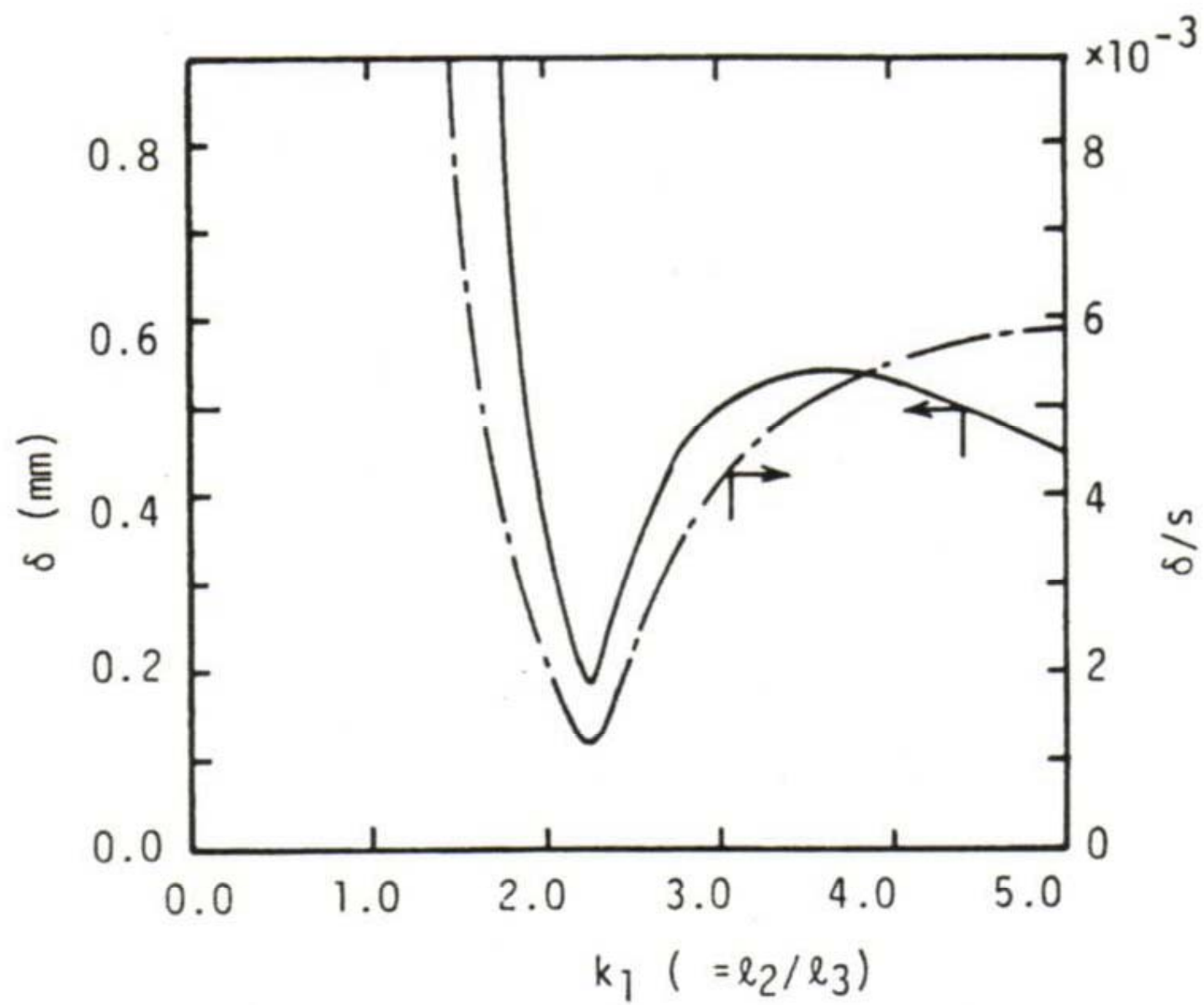
脚の動き

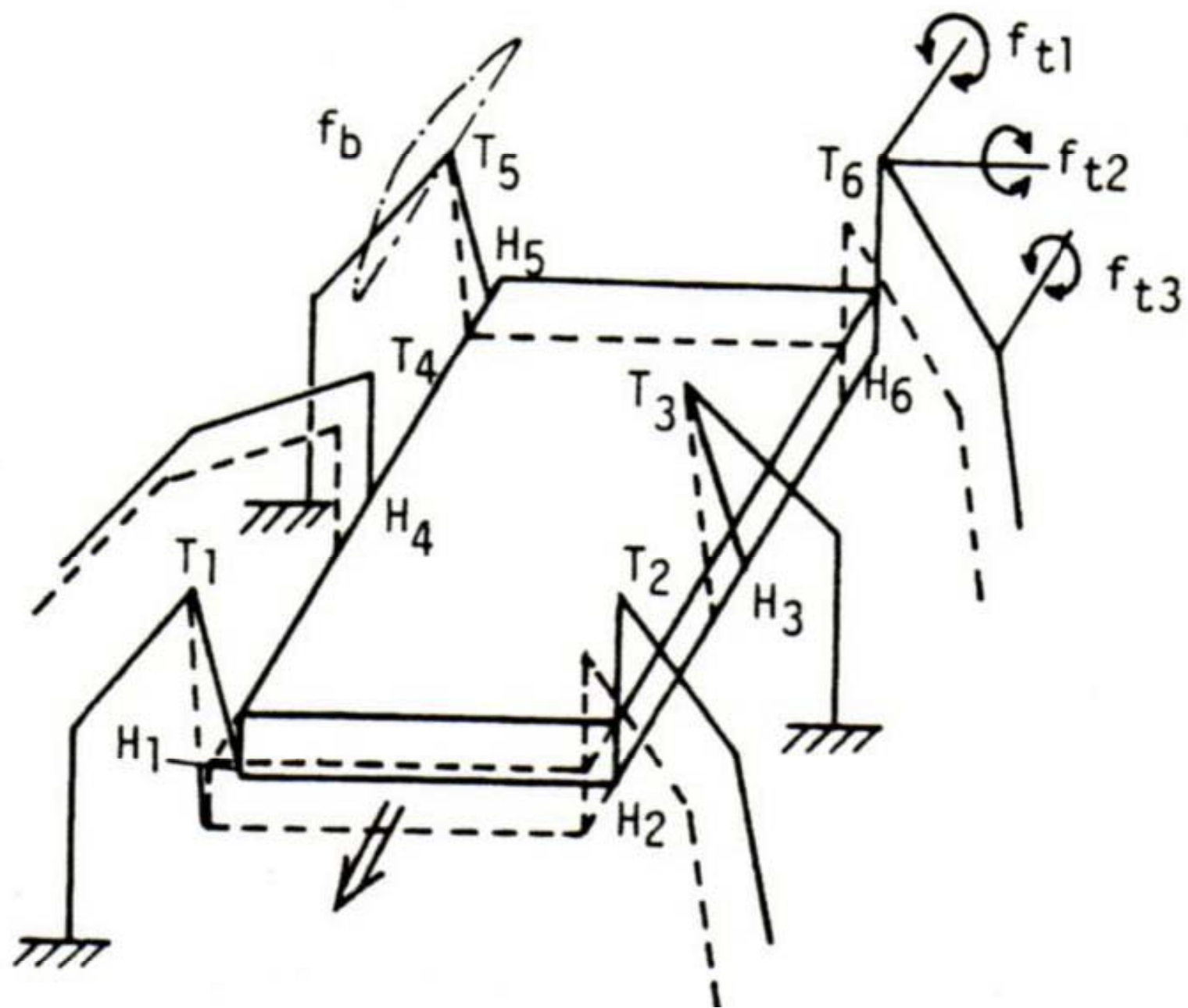


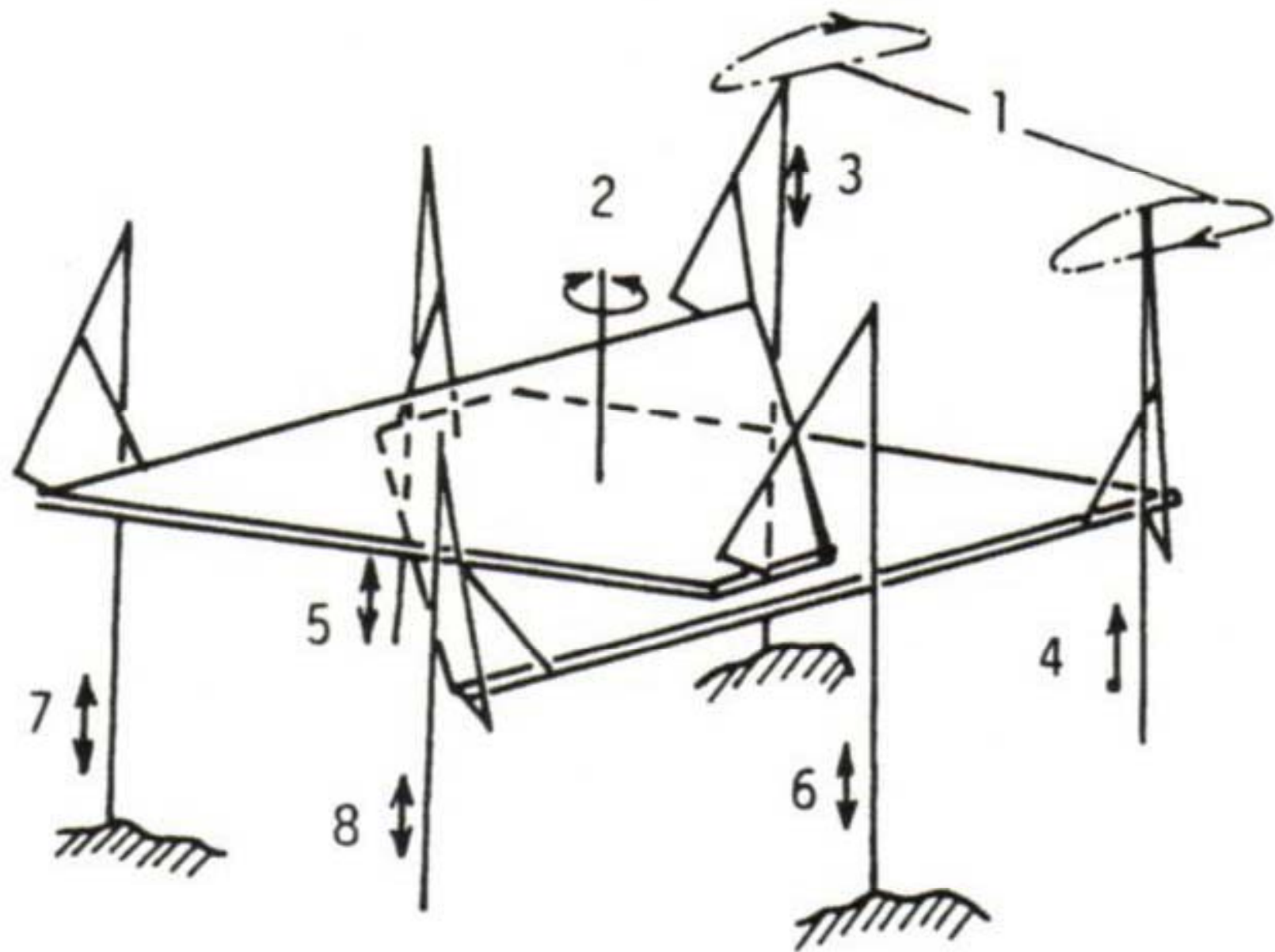
4節リンク機構

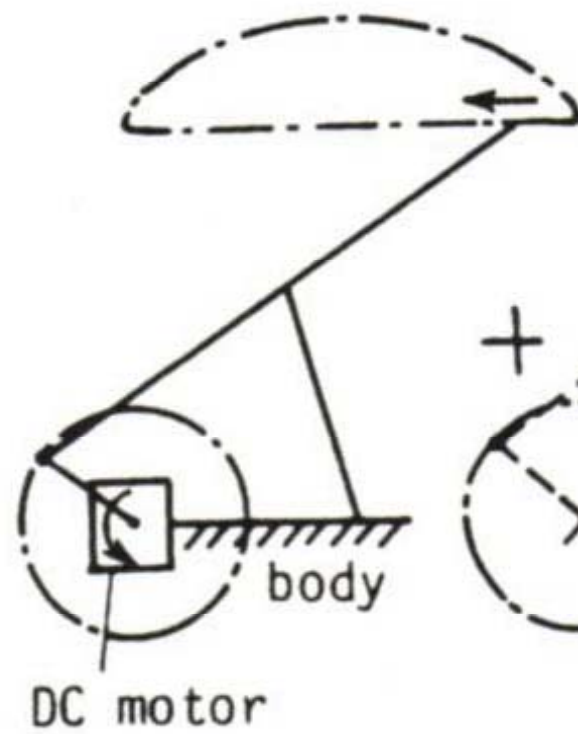




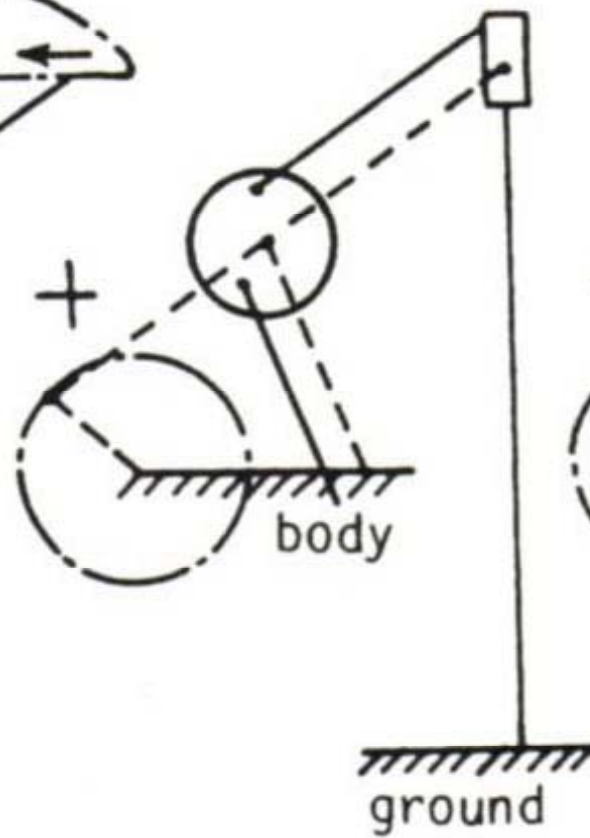




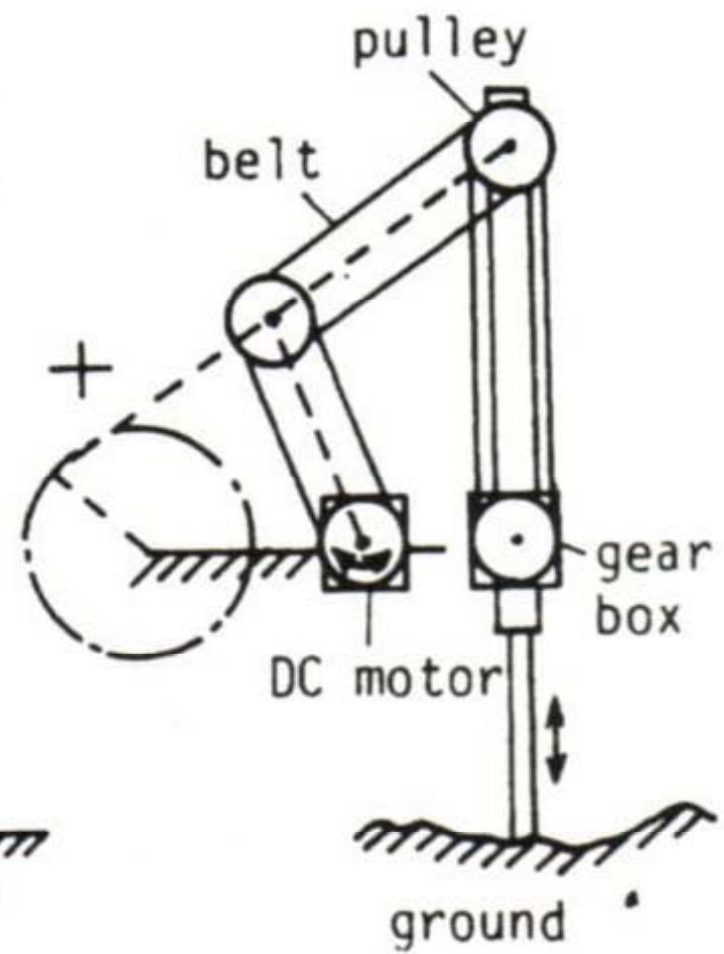




(a)

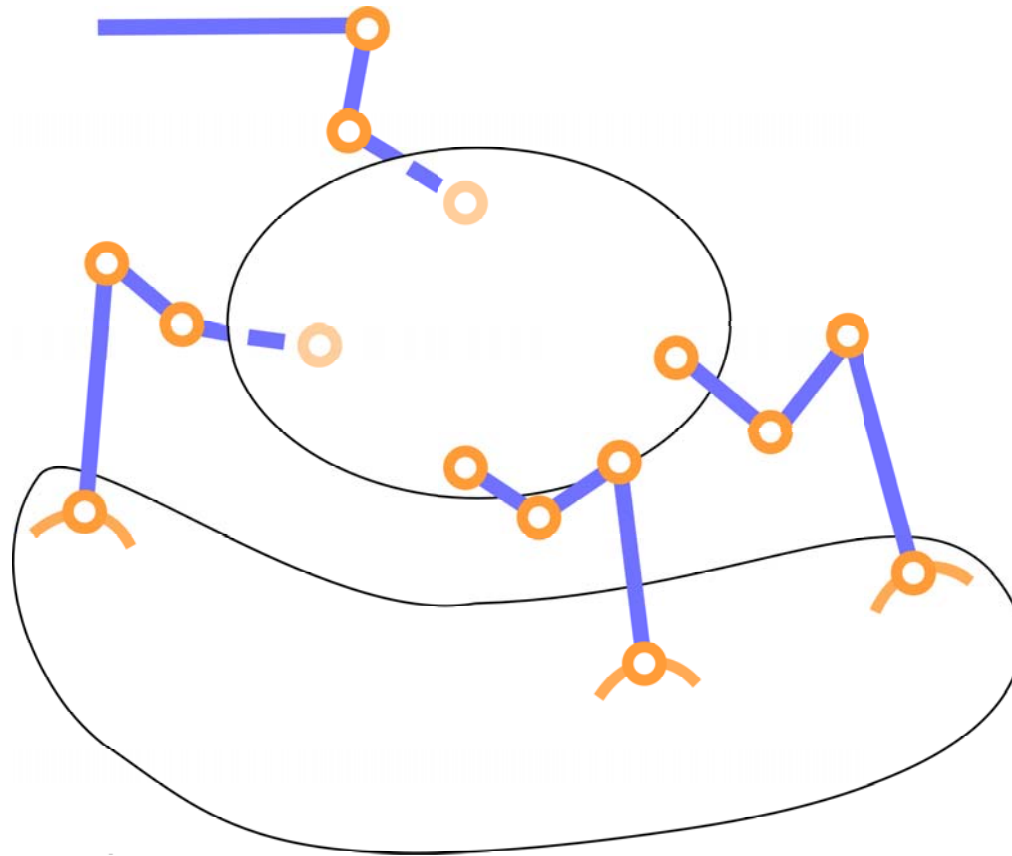


(b)

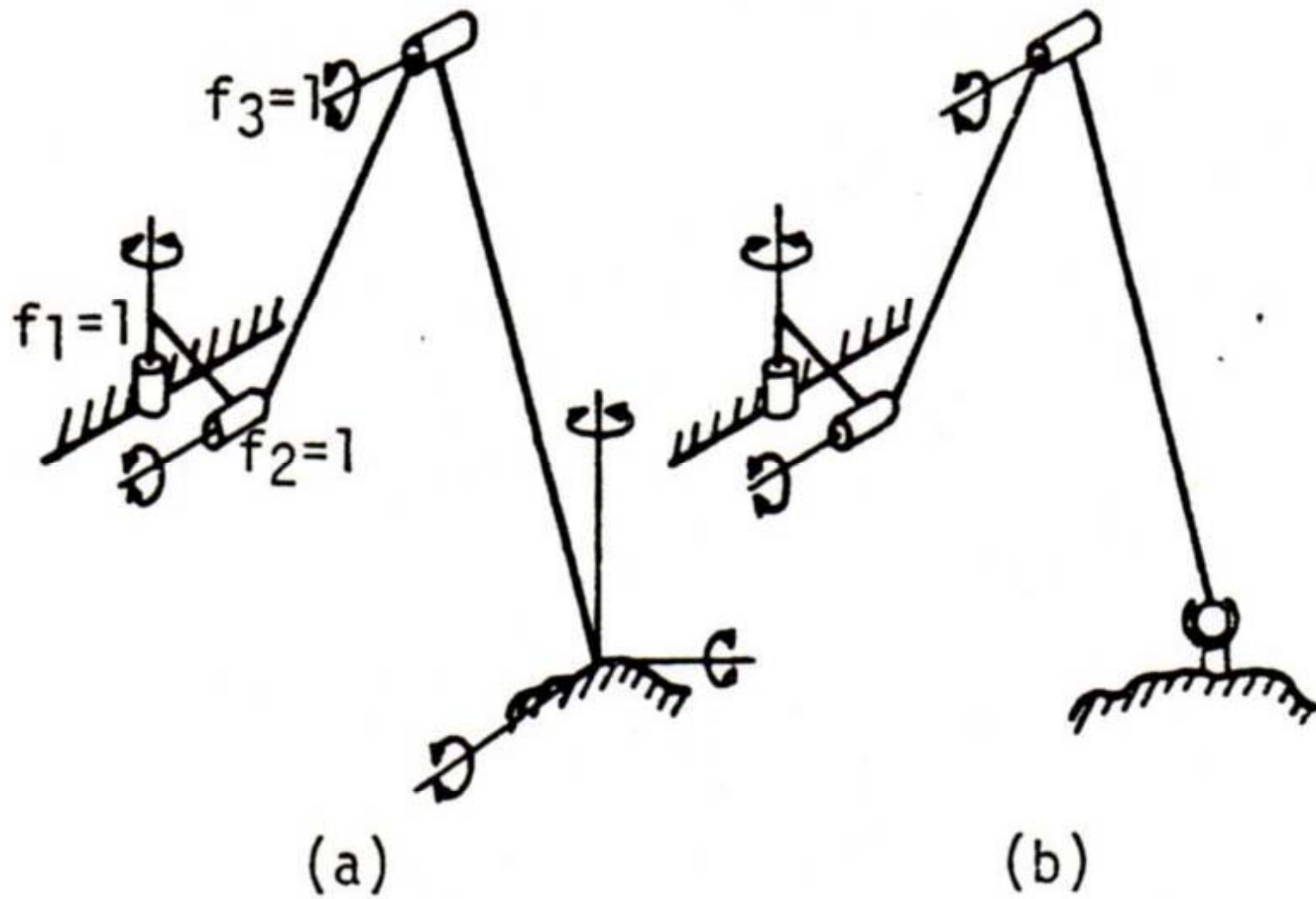


(c)

最低限の機能を有する4足歩行ロボットの 最低能動自由度？

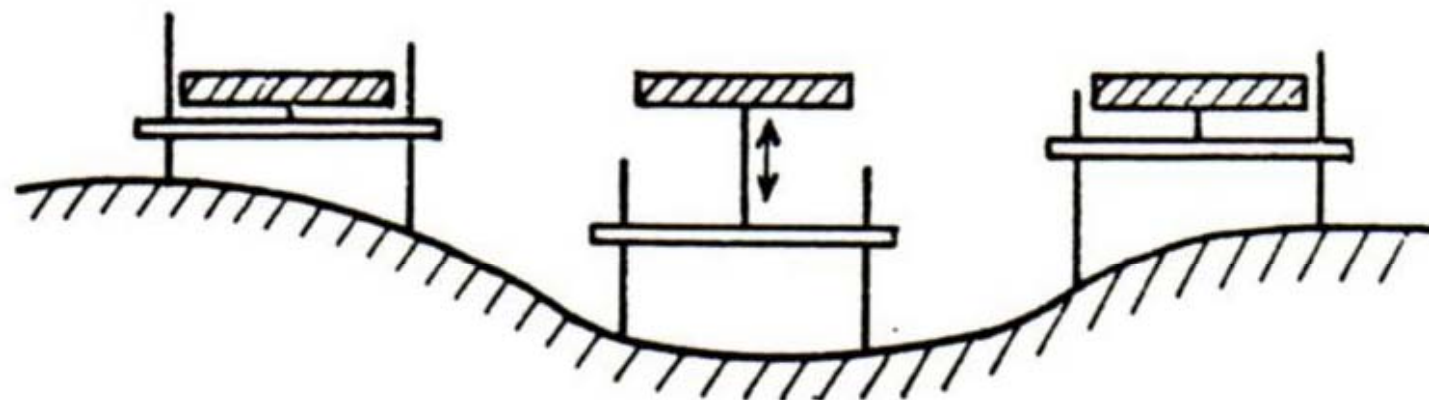


キャプション無し

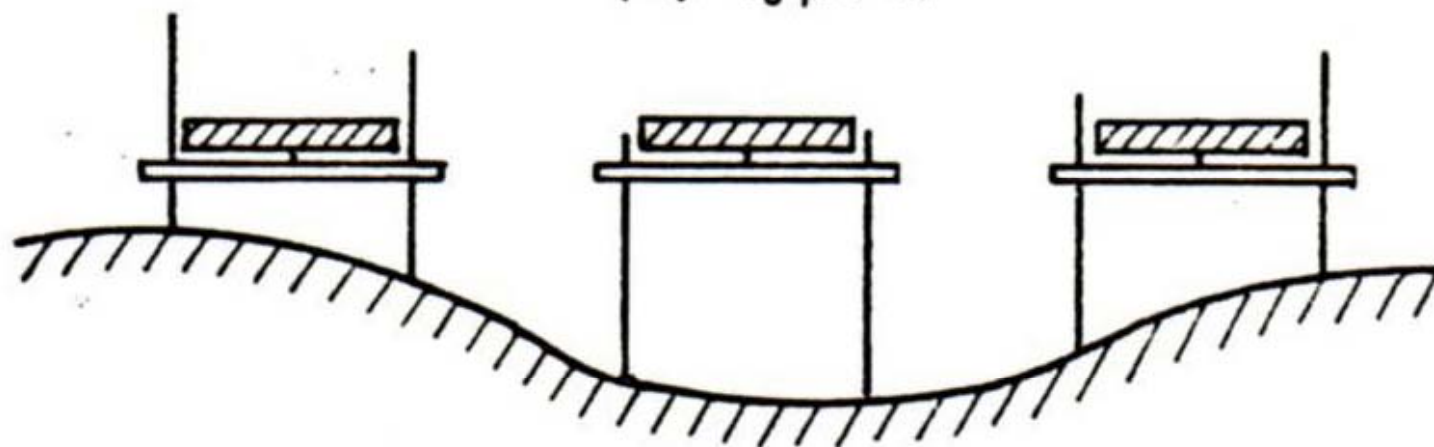


キャプション無し

 : Main body

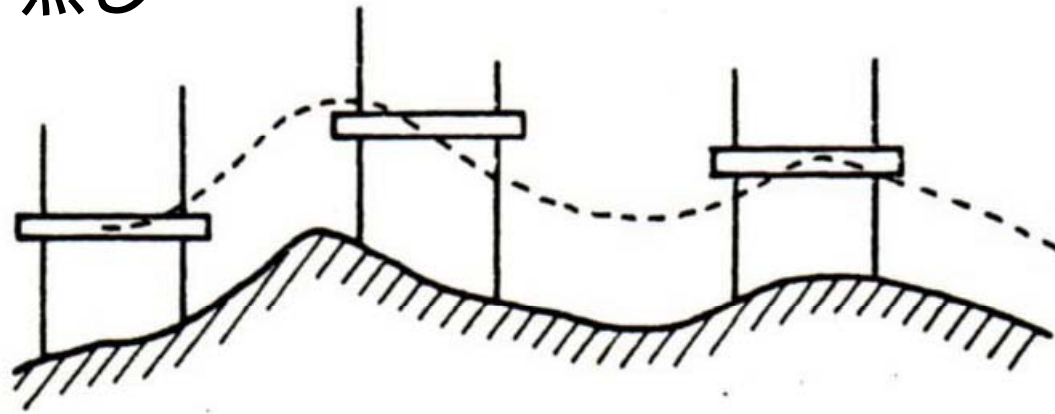


(a) Type A

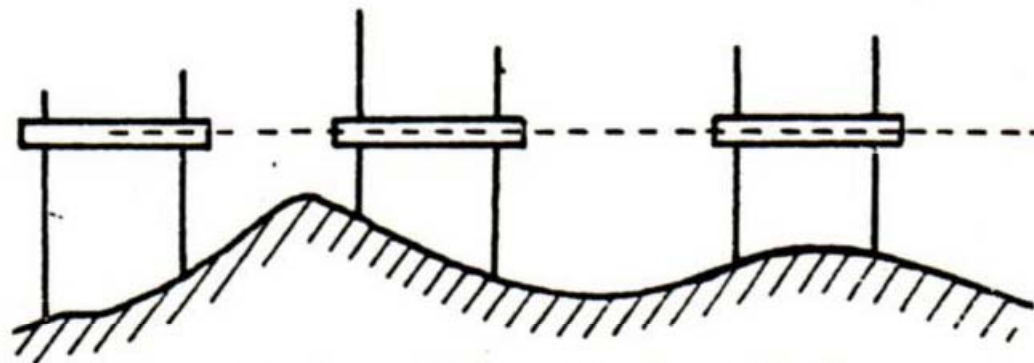


(b) Type B

キャプション無し

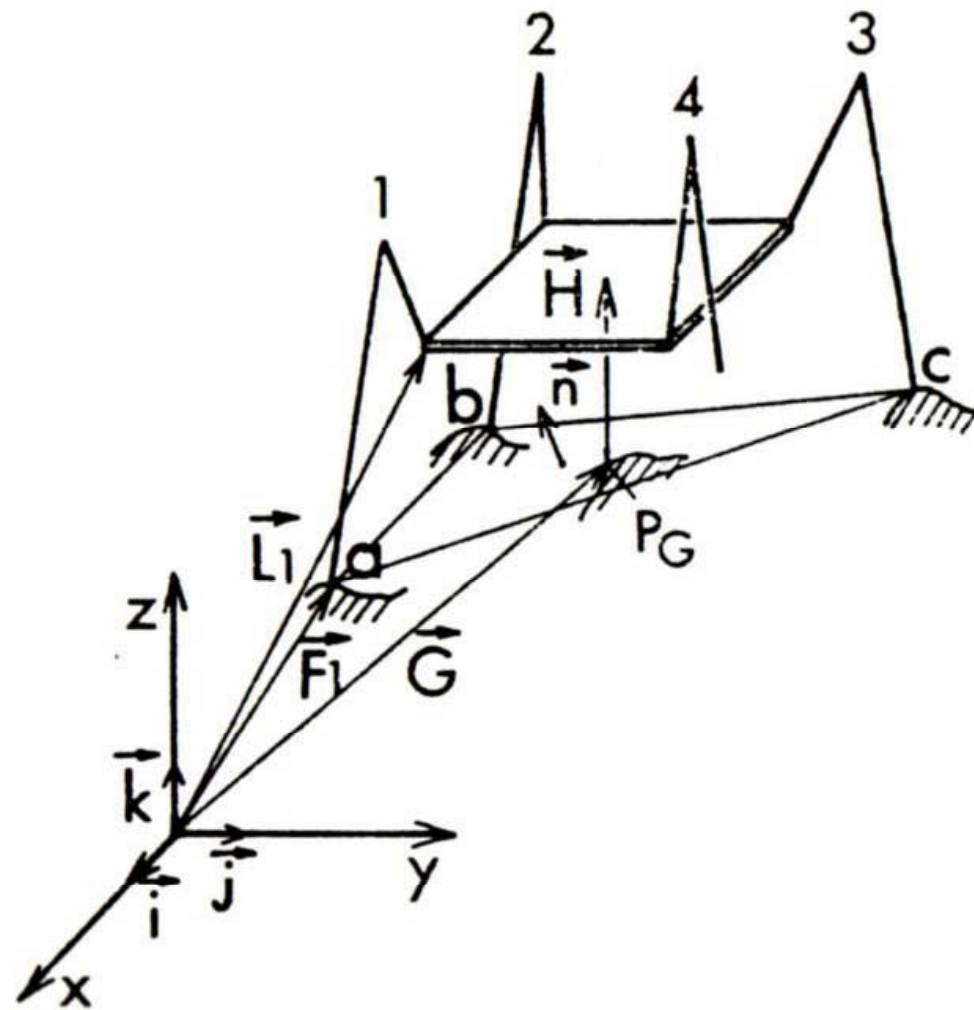


(a) Walking in level 3



(b) Walking in level 4

キャプション無し



キャプション無し

