Today’s topic:

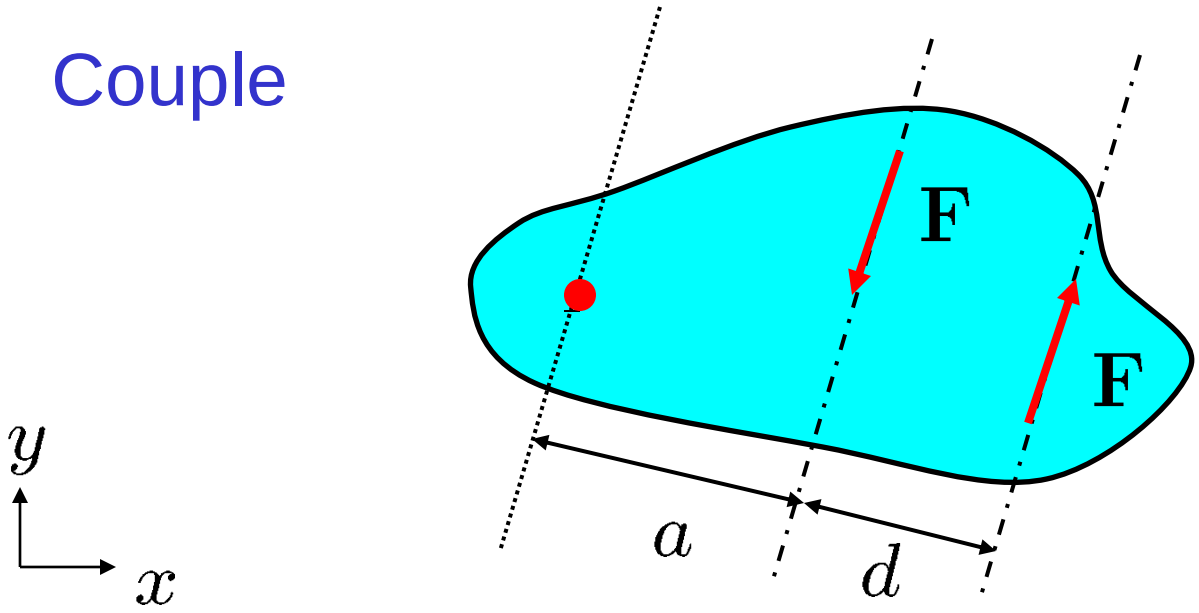
- Statically equivalent system of forces

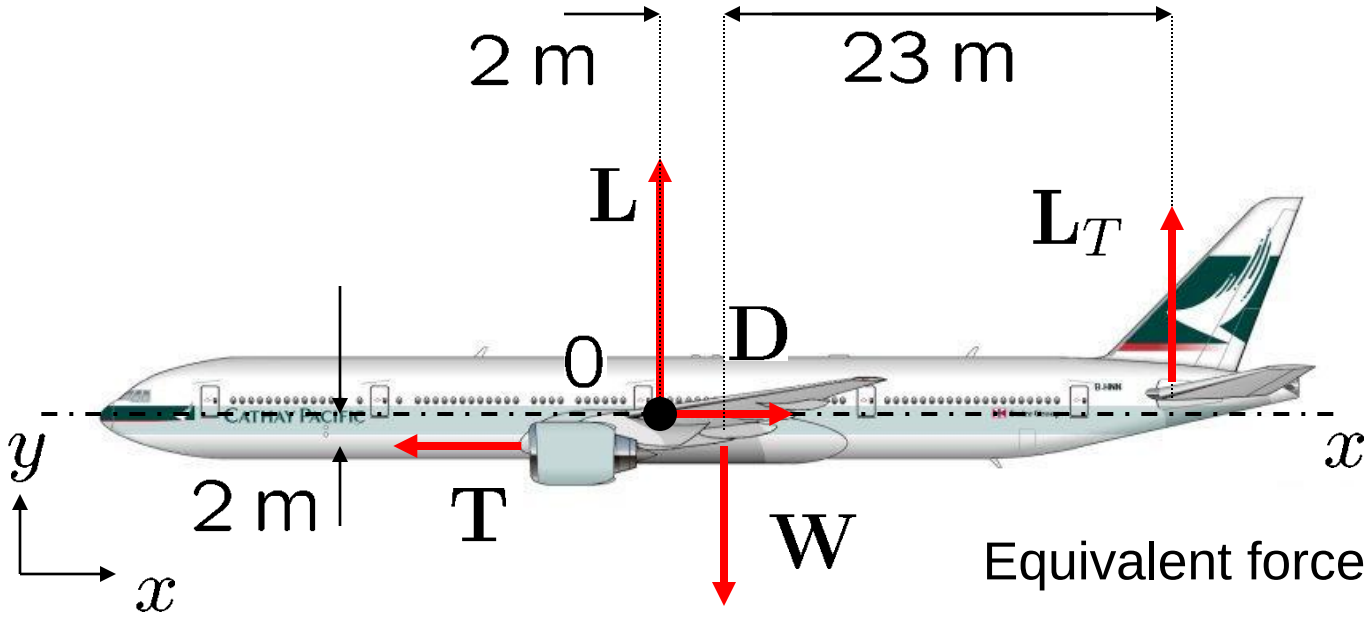
Book: Chapter 3.1 - 3.3

Varignon's principle

The moment of a force about any point is equal to the sum of the moments of the components of this force.

Couple





$\mathbf{L} = 2.4\,\mathrm{MN}$

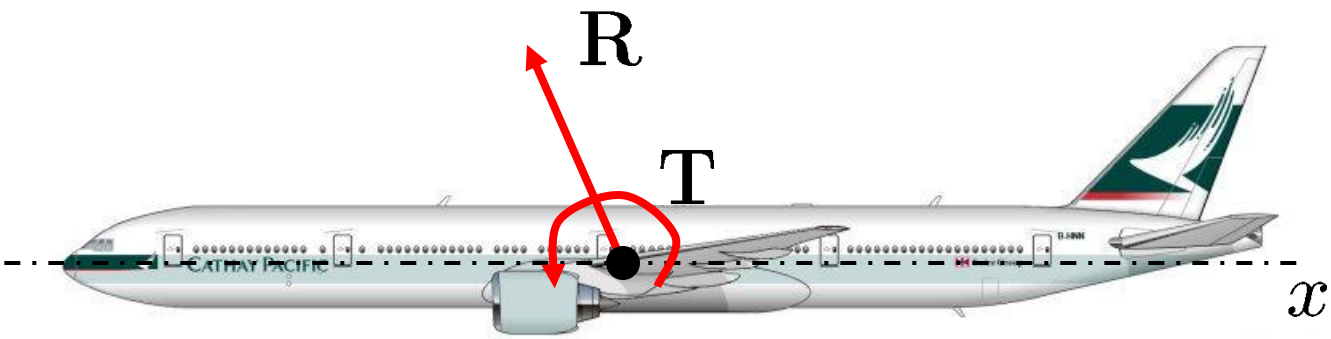
$\mathbf{L}_T = 0.3\,\mathrm{MN}$

$\mathbf{W} = 2.5\,\mathrm{MN}$

$\mathbf{T} = 0.8\,\mathrm{MN}$

$\mathbf{D} = 0.7\,\mathrm{MN}$

Equivalent force couple in 0 ?

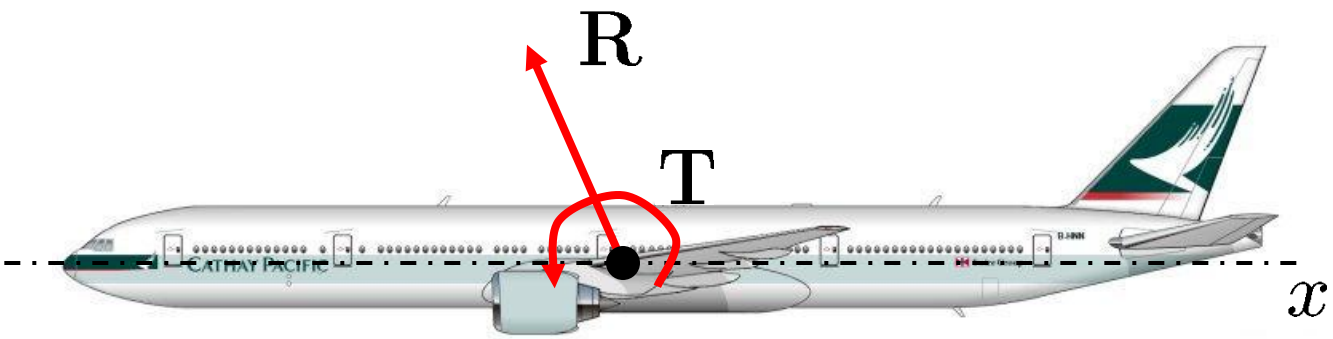

R
T
CATHAY PACIFIC
x

Resultant force

A single resultant force in a specific point that replaces all forces and couples in a body

$$\mathbf{R} = \sum \mathbf{F}$$

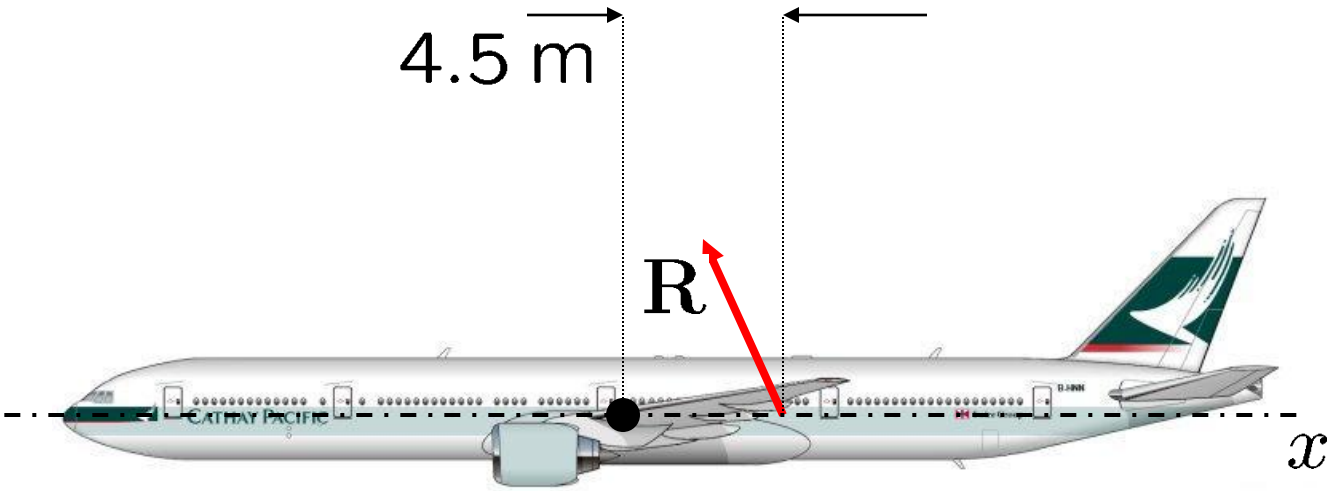
$$\mathbf{M}_o = \sum \left(\mathbf{d} \times \mathbf{F} \right) = 0$$

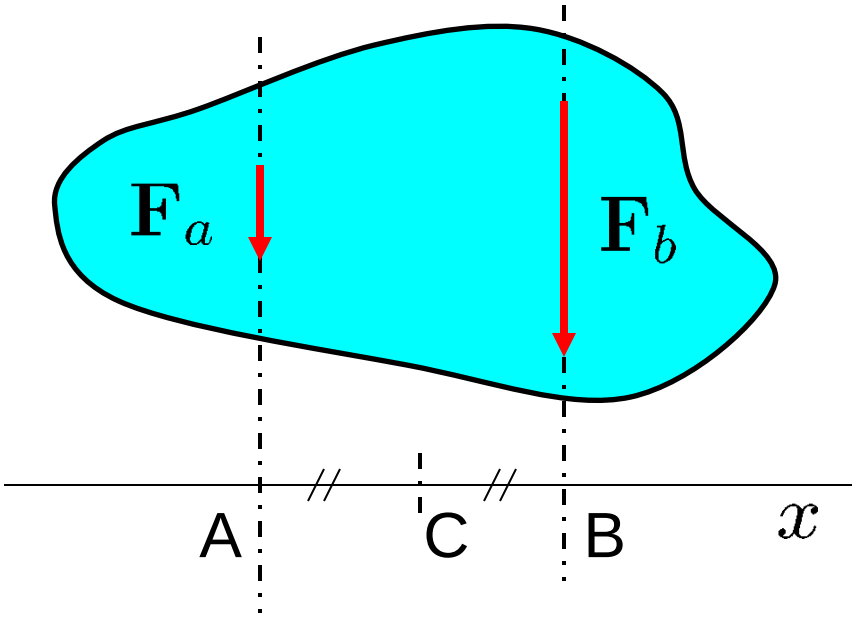


$$\mathbf{R} = \begin{bmatrix} -0.1 \\ 0.2 \end{bmatrix}$$

$$\mathbf{T} = 0.9$$

Position of resultant force along x -axis

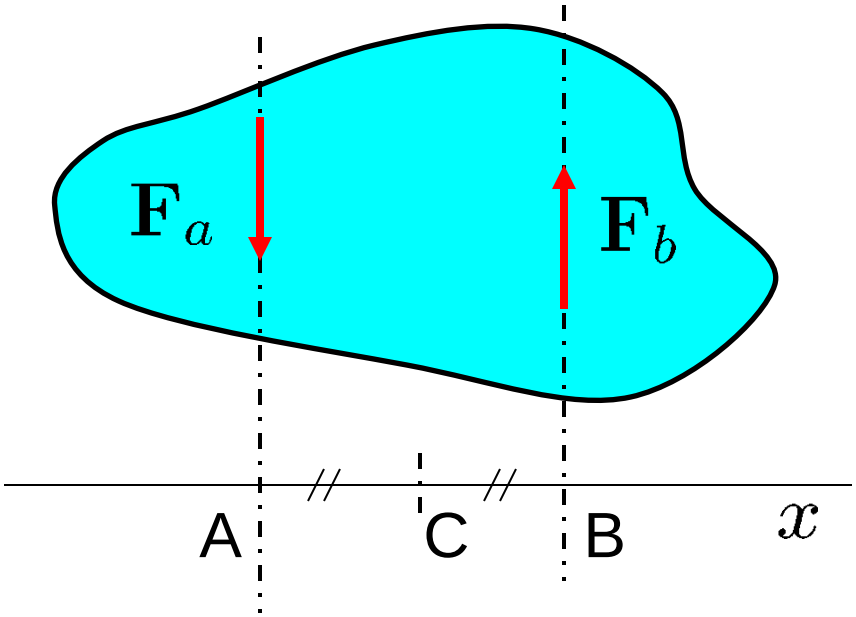

4.5 m
R
CATHAY PACIFIC
x



$$\mathbf{F}_b > \mathbf{F}_a$$

Where does the line of action of the resultant cross the x-axis?

A) Close to A
B) Close to B
C) In C
D) Somewhere else



$$\mathbf{F}_b = \mathbf{F}_a$$

Where does the line of action of the resultant cross the x-axis?

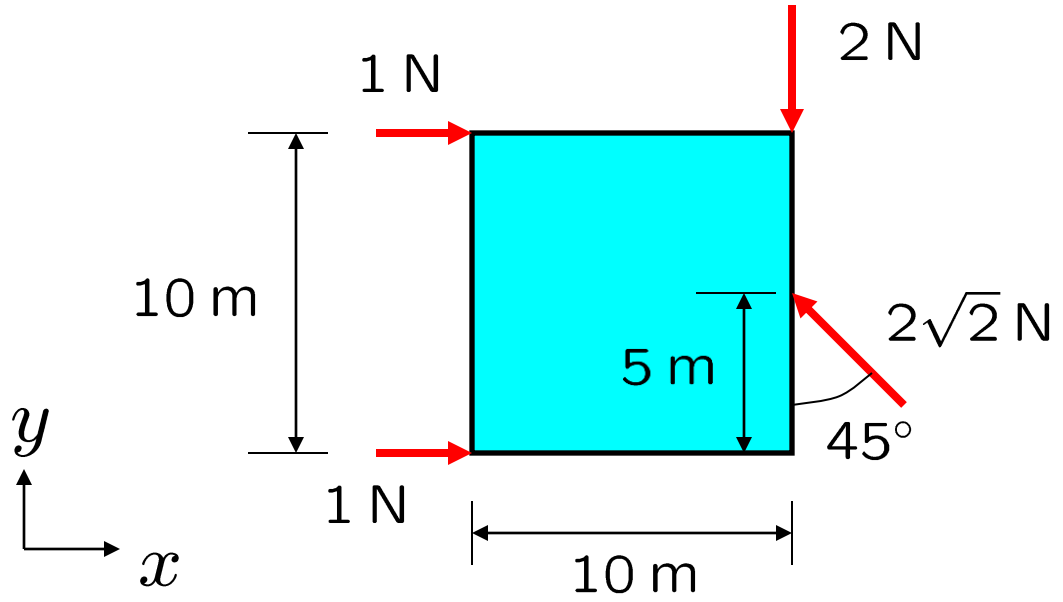
A) Close to A
B) Close to B
C) In C
D) It does not

Static equilibrium of a body (Newton's first law)

The equivalent force and moment in any point is equal to zero.

$$\mathbf{R} = 0$$

$$\mathbf{T} = 0$$



Check equilibrium

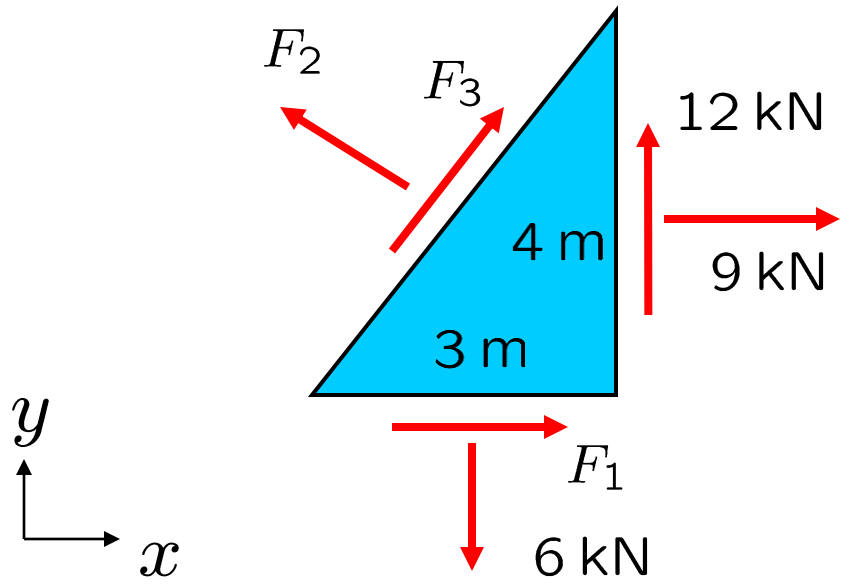
Static equilibrium of a body

In general:

$$\sum \mathbf{F}_x = 0$$

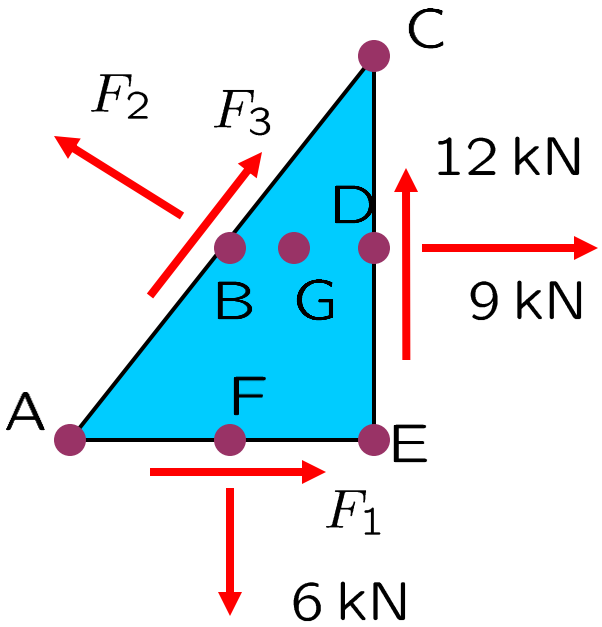
$$\sum \mathbf{F}_y = 0$$

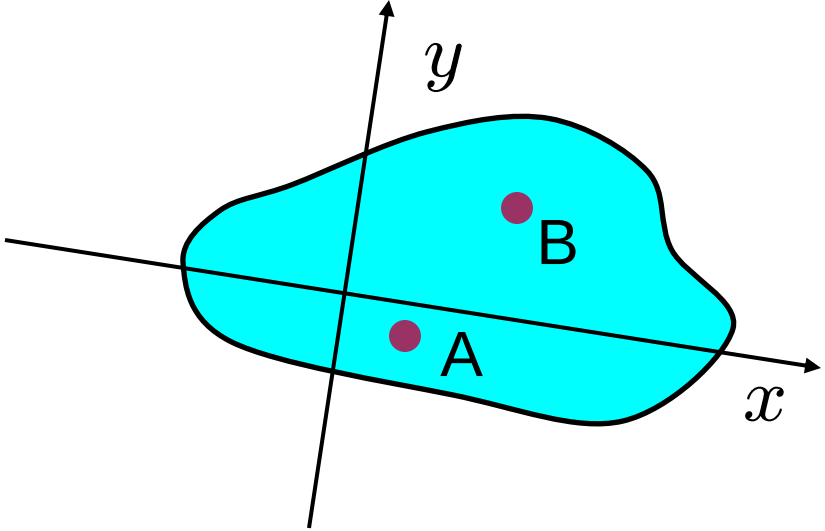
$$\sum \mathbf{M}_A = 0$$



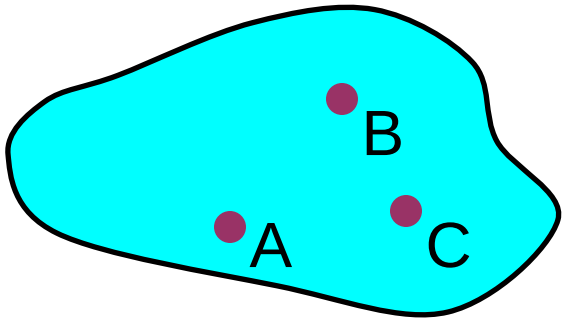
The body is in equilibrium.

Calculate F_1,F_2 and F_3

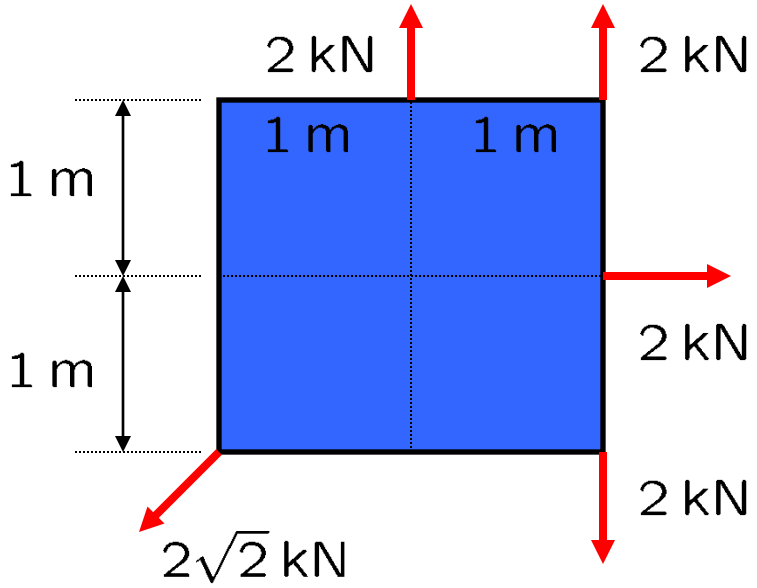

C
F_2
F_3
12 kN
D
B
G
9 kN
A
F
E
F_1
6 kN



$$\sum \mathbf{F}_x = 0, \quad \sum \mathbf{M}_A = 0, \quad \sum \mathbf{M}_B = 0$$



$$\sum \mathbf{M}_A = 0, \quad \sum \mathbf{M}_B = 0, \quad \sum \mathbf{M}_C = 0$$



Is the body in equilibrium?

Recap: Static equilibrium of a body

In general:

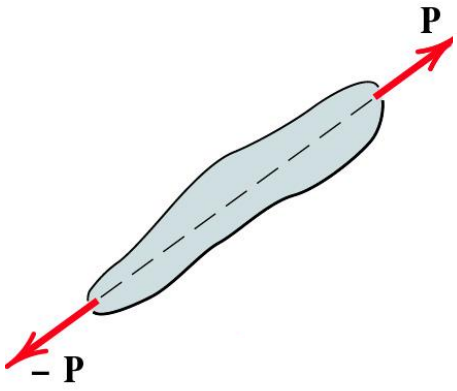
$$\sum \mathbf{F}_x = 0$$

$$\sum \mathbf{F}_y = 0$$

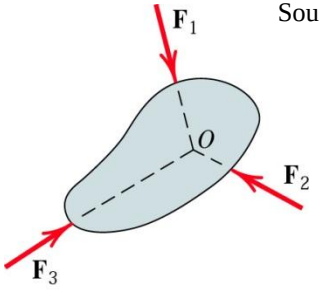
$$\sum \mathbf{M}_A = 0$$

Two- and three-force members

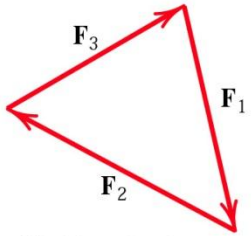
Source: R.C. Hibbeler,
"Engineering Mechanics – Statics"



Two-force member



(*a*) Three-force member



(*b*) Closed polygon satisfies $\Sigma \mathbf{F} = \mathbf{0}$

Free-body diagram

A diagrammatic representation of the isolated system treated as a single body.