



Chapter 5 – Equilibrium Rigid Bodies

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The submarine is a rigid body subjected to multiple forces (own weight, tension of cables, etc.) All these forces are not concurrent. If the submarine does not translate or rotate, then the sum of forces and moments is zero.

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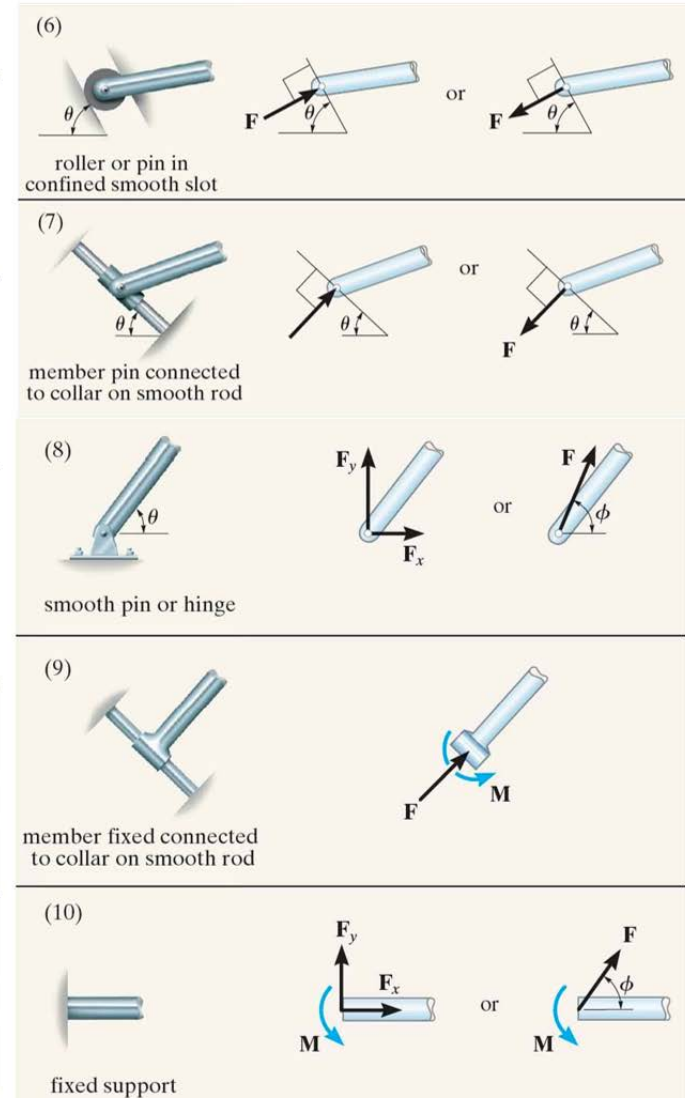
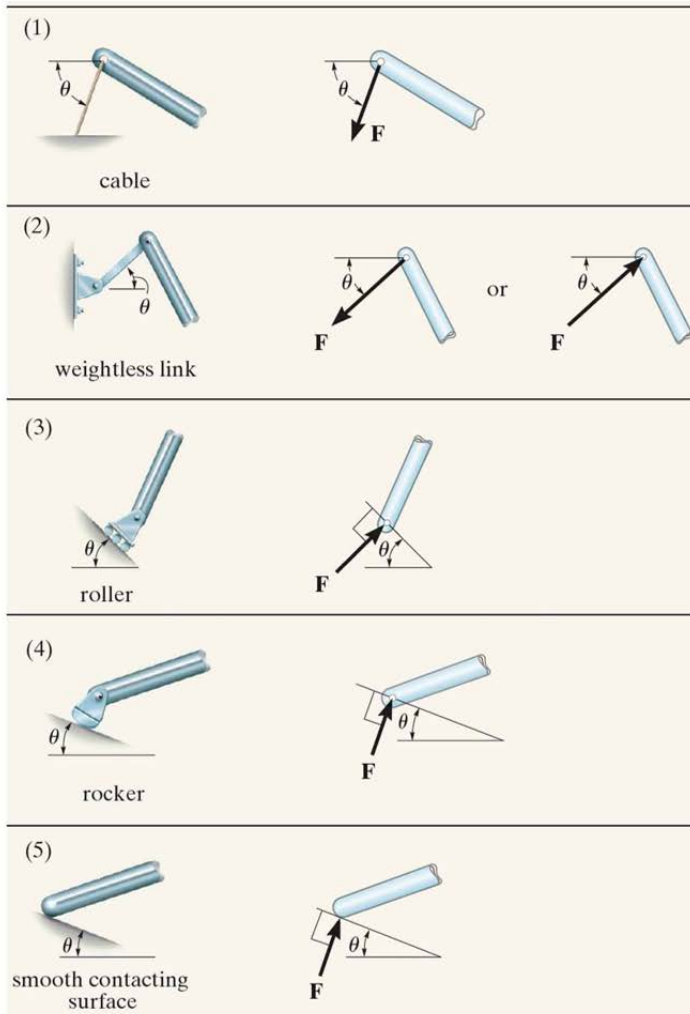
Equations of Equilibrium - Coplanar

Equations of equilibrium and supports

$$\sum F_{Rx} = 0$$

$$\sum F_{Ry} = 0$$

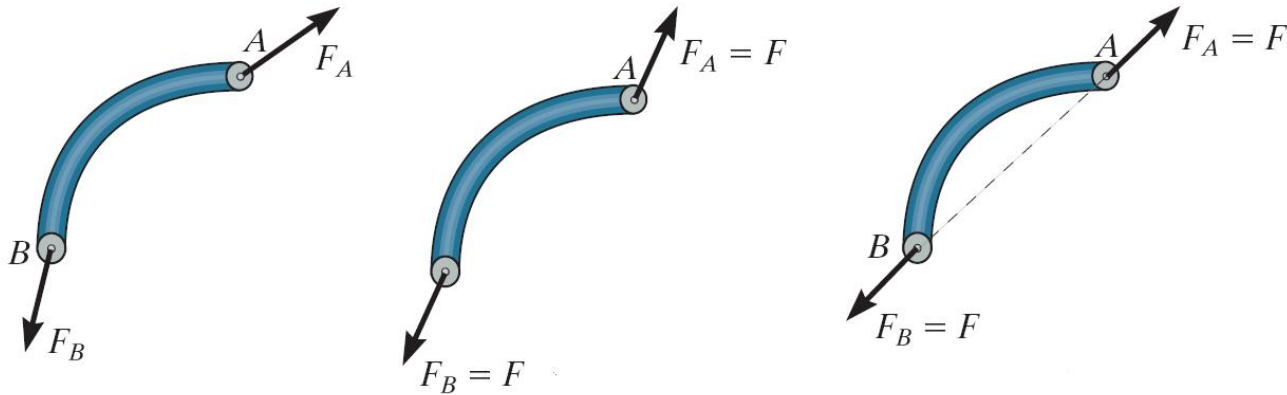
$$\sum M_{O_z} = 0$$



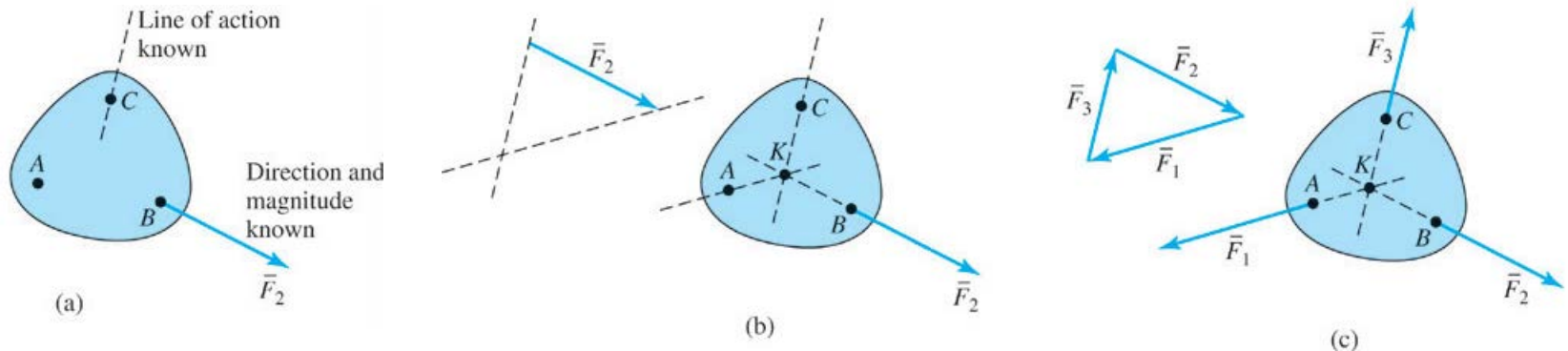


Two- and Three-Force Members

Two-Force Members



Three-Force Members

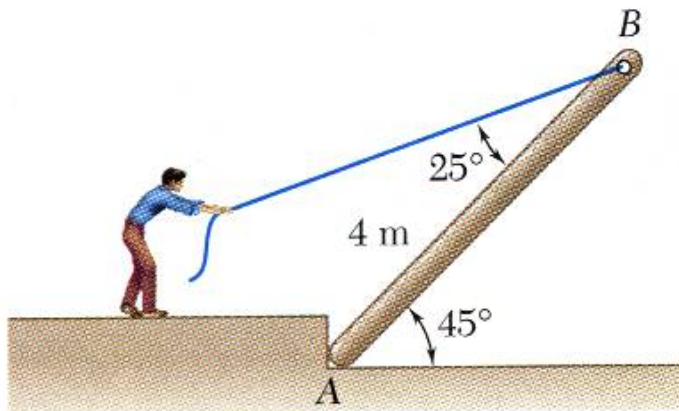




Example

A man raises a 10 kg joist, of length 4 m, by pulling on a rope. Find the tension in the rope and the reaction at A.

- a) Using the graphical method
- b) Using rectangular components





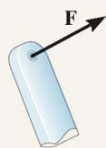
Equations of Equilibrium - Spatial

Equations of equilibrium and supports

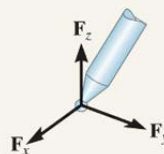
$$\sum F_x = 0; \quad \sum F_y = 0; \quad \sum F_z = 0; \quad \sum M_{O_x} = 0; \quad \sum M_{O_y} = 0; \quad \sum M_{O_z} = 0;$$



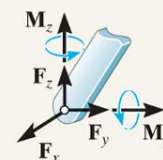
cable



ball and socket



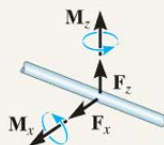
single smooth pin



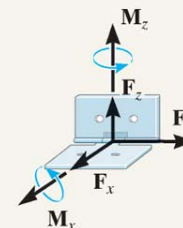
smooth surface support



single journal bearing



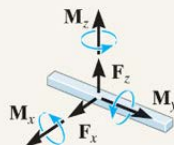
single hinge



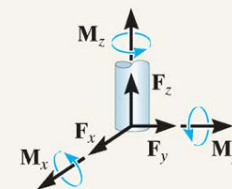
roller



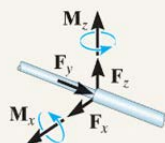
single journal bearing
with square shaft



fixed support



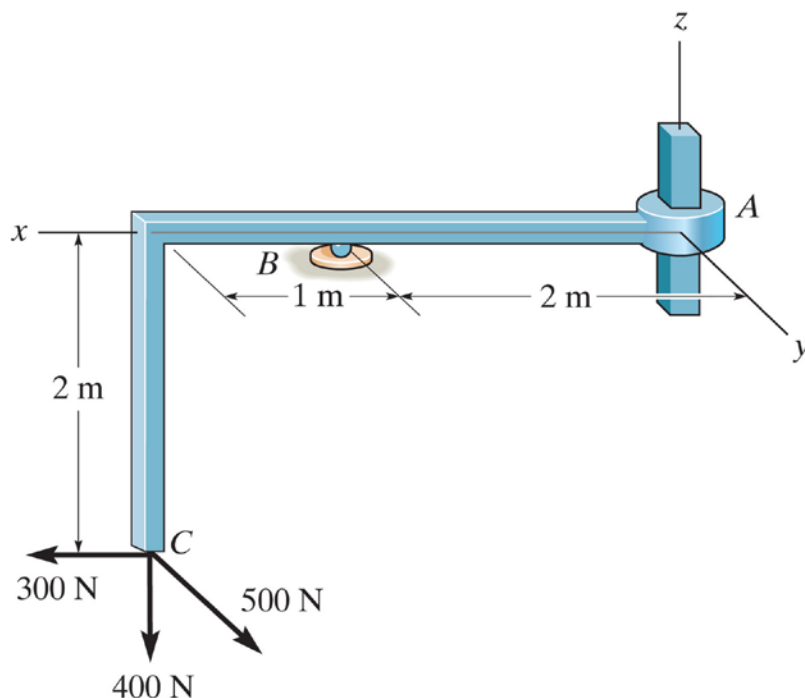
single thrust bearing





Example

The member is supported by a square rod which fits loosely through the smooth square hole of the attached collar at A and by a roller at B . Determine the components of reaction at these supports when the member is subjected to the loading shown.





Example

The bent rod is supported at A , B , and C by smooth journal bearings. Determine the magnitude of \mathbf{F}_2 which will cause the reaction \mathbf{C}_y at the bearing C to be equal to zero. The bearings are in proper alignment and exert only force reactions on the rod. Set $F_1 = 300$ lb.

