Equilibrium of rigid bodies: Part 2

Equivalent resultant system (Equilibrium in two dimensions):
As mentioned in "Force and moments chapter", we follow the steps below for finding the unknowns in a system.

1) Move all forces and moments to point O,
2) Upon moving forces to point O, moments are produced (Fig. b):

$$\boldsymbol{M}_1 = \boldsymbol{r}_1 \times \boldsymbol{F}_1$$

$$\boldsymbol{M}_2 = \boldsymbol{r}_2 \times \boldsymbol{F}_2$$

3) M_c can be moved freely to point O,
4) The total resultant force and moments are (Fig. c)

$$\boldsymbol{F}_R = \sum \boldsymbol{F}$$

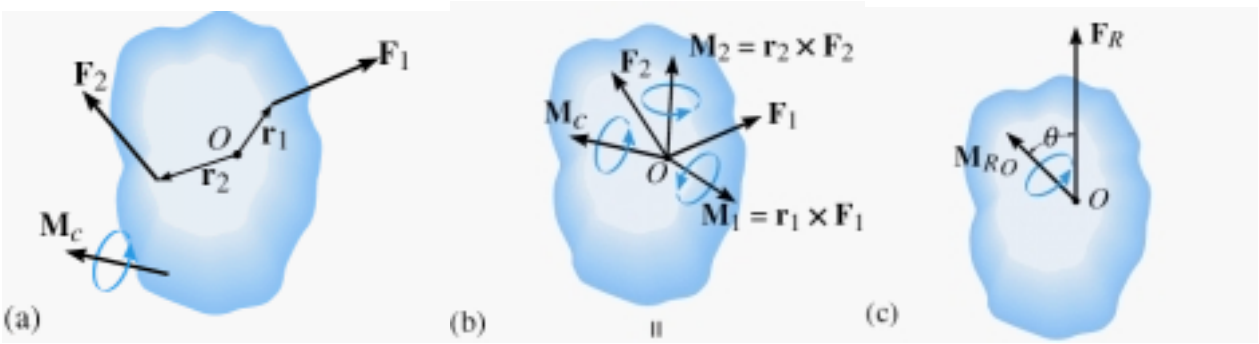
$$\boldsymbol{M}_{RO} = \sum \boldsymbol{M}_C + \sum \boldsymbol{M}_O$$

5) To find the unknowns, consider the following equations:

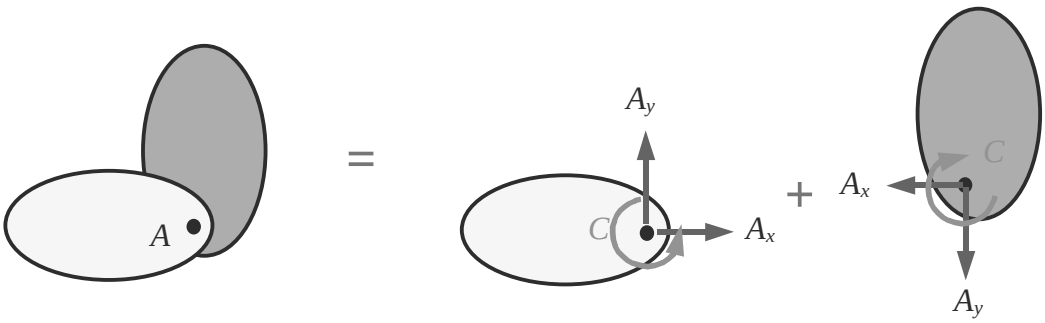
$$\boldsymbol{F}_{Rx} = \sum \boldsymbol{F}_x = 0$$

$$\boldsymbol{F}_{Ry} = \sum \boldsymbol{F}_y = 0$$

$$\sum \boldsymbol{M}_{RO} = 0$$



Composite bodies and internal forces: Forces and couples which are a result of interaction between one part of an object and another part of it will not appear in the free-body diagram of the whole object. This is due to Newton's 3rd law. The two bodies in the following example are welded at A. When the two parts are looked at as a single body, the internal forces and couples are added together, and as a result of Newton's third law will cancel.



Forces and couples on a free-body diagram (FBD): Each force or couple on a FBD represents a model of how the body in the free-body diagram is effected by its surroundings. In selecting the forces and couples that are to be applied follow these steps:

- Identify all the forces which come from the interaction of one body with another (Refer to support reactions section). Remember that for each way in which a support restricts the free motion of the body, a force or a moment must be applied to the body to impose the restriction on the motion.
- Apply the weight of the body to its center of gravity (if it is uniform, then apply it to the centroid).
- Remember that strings and cables can only pull on an object.
- Remember that internal loads cancel out and should not be put on the FBD.
- Remember that if you have selected the direction of forces or couples of interaction on one body, then Newton's 3rd law states that you must apply the forces or couples in the opposite direction on the other body.