Static Equilibrium

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Version of 24 August 2009

★ Static equilibrium for a rigid body.

• Sum of forces must be zero:

$$\sum_j \boldsymbol{F}_j = \boldsymbol{0} \tag{1}$$

• Sum of torques must be zero:

$$\sum_j \boldsymbol{N}_j = \boldsymbol{0}; \quad \boldsymbol{N}_j = \boldsymbol{r}_j \times \boldsymbol{F}_j \tag{2}$$

★ Note that $\boldsymbol{r}_j$ depends upon choice of origin of coordinates. See exercise.

□ Exercise. Show that the choice of origin used for calculating the torques does not matter as long as the sum of the forces is zero.

□ Exercise. A ladder leaning against the wall makes an angle θ with the floor. Show that if the floor is frictionless the ladder cannot be in static equilibrium for $0 < \theta < 90°$. What is the minimum coefficient of static friction μ_s for which the ladder will be in equilibrium?

□ Exercise. A diving board of total length 5 m and mass 30 kg is resting on a stand at one edge of a swimming pool. Assume the stand has a width of 1 m and the board is bolted to the stand 5 cm from the edge of the stand furthest from the swimming pool. Estimate the force the bolts are exerting on the board if a diver of mass 70 kg is standing on the end over the water.

□ Exercise. A tripod carrying a video camera of mass 5 kg is placed on a smooth floor. Assume each leg of the tripod is of length 2 m and makes an angle of 30° with the vertical, and the total mass of the legs is 1 kg. What force, magnitude and direction, does the floor exert on each leg? Is the answer unique?

□ Exercise. Assume that for the previous exercise the floor is not perfectly smooth, so frictional forces may be present. What can you say about them?