Static Equilibrium

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Version of 24 August 2009

- Static equilibrium for a rigid body.
  - Sum of forces must be zero:
    \[ \sum_j F_j = 0 \]  (1)
  - Sum of torques must be zero:
    \[ \sum_j N_j = 0; \quad N_j = r_j \times F_j \]  (2)

* Note that \( r_j \) 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 \( \theta \) with the floor. Show that if the floor is frictionless the ladder cannot be in static equilibrium for \( 0 < \theta < 90^\circ \). What is the minimum coefficient of static friction \( \mu_s \) 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?