Chapter 11

Equilibrium and Elasticity

PowerPoint® Lectures for
University Physics, Twelfth Edition
– Hugh D. Young and Roger A. Freedman

Lectures by James Pazun

Introduction

- Isn’t it beautiful? You need to know conditions for equilibrium to be a good engineer.

San Francisco's Golden Gate Bridge

Conditions for equilibrium

$$\sum \mathbf{F} = 0 \quad or$$

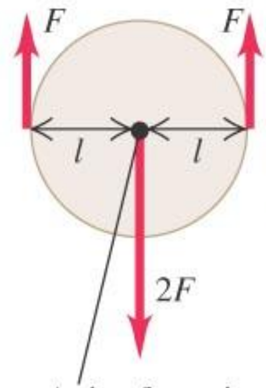
$$\sum F_x = 0 \quad \sum F_x = 0 \quad \sum F_x = 0$$

and

$$\sum \boldsymbol{\tau} = 0$$

(a) This body is in static equilibrium.

Equilibrium conditions:

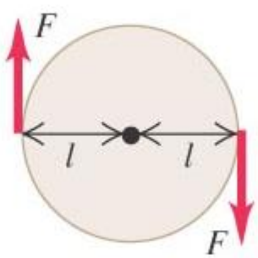


First condition satisfied: Net force = 0, so body at rest has no tendency to start moving as a whole.

Second condition satisfied: Net torque about the axis = 0, so body at rest has no tendency to start rotating.

Axis of rotation (perpendicular to figure)

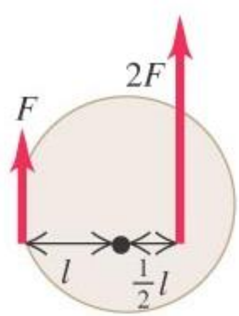
(b) This body has no tendency to accelerate as a whole, but it has a tendency to start rotating.



First condition satisfied: Net force = 0, so body at rest has no tendency to start moving as a whole.

Second condition NOT satisfied: There is a net clockwise torque about the axis, so body at rest will start rotating clockwise.

(c) This body has a tendency to accelerate as a whole but no tendency to start rotating.

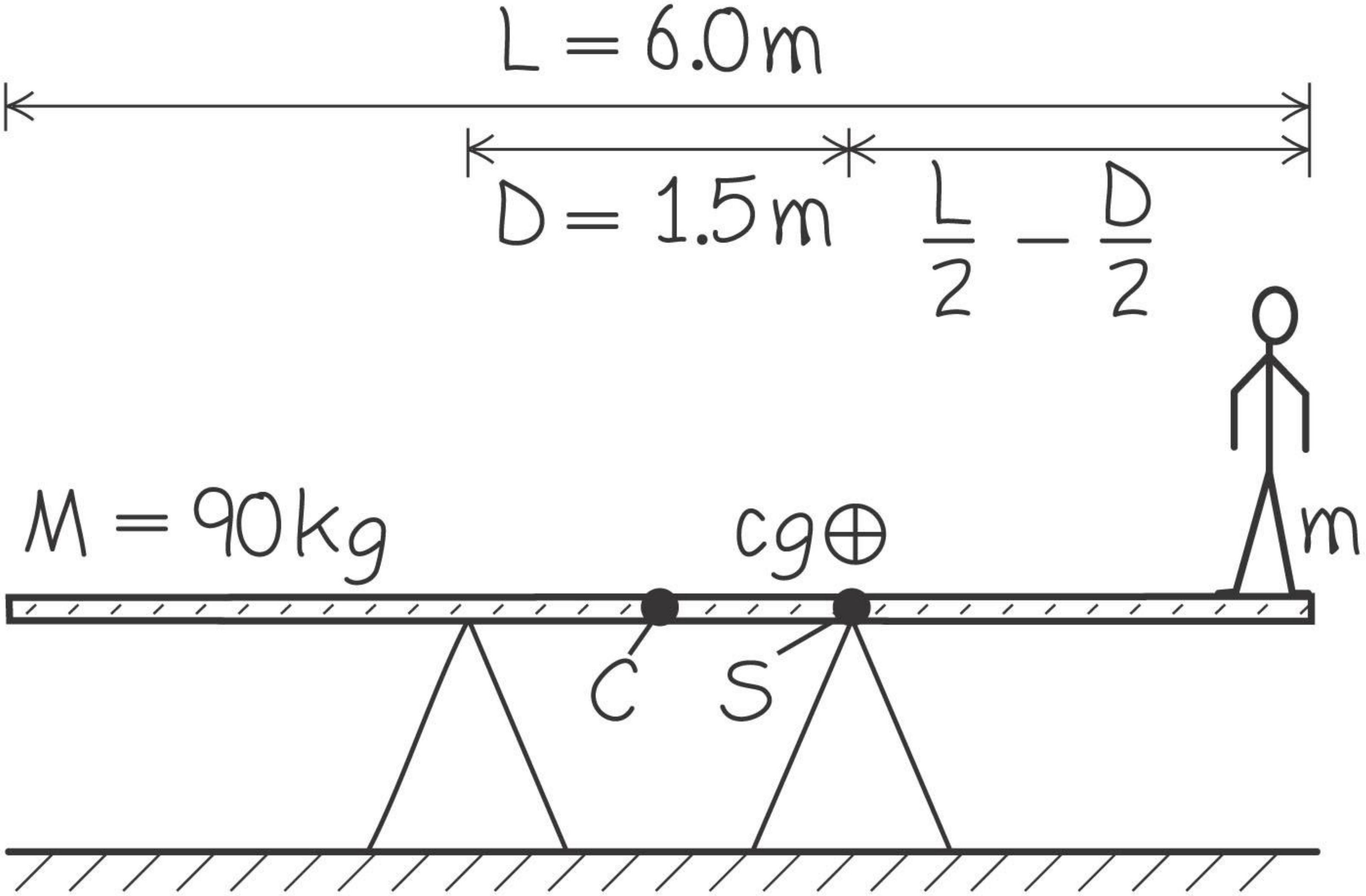


First condition NOT satisfied: There is a net upward force, so body at rest will start moving upward.

Second condition satisfied: Net torque about the axis = 0 so body at rest has no tendency to start rotating.

A “teeter-totter” balancing torques

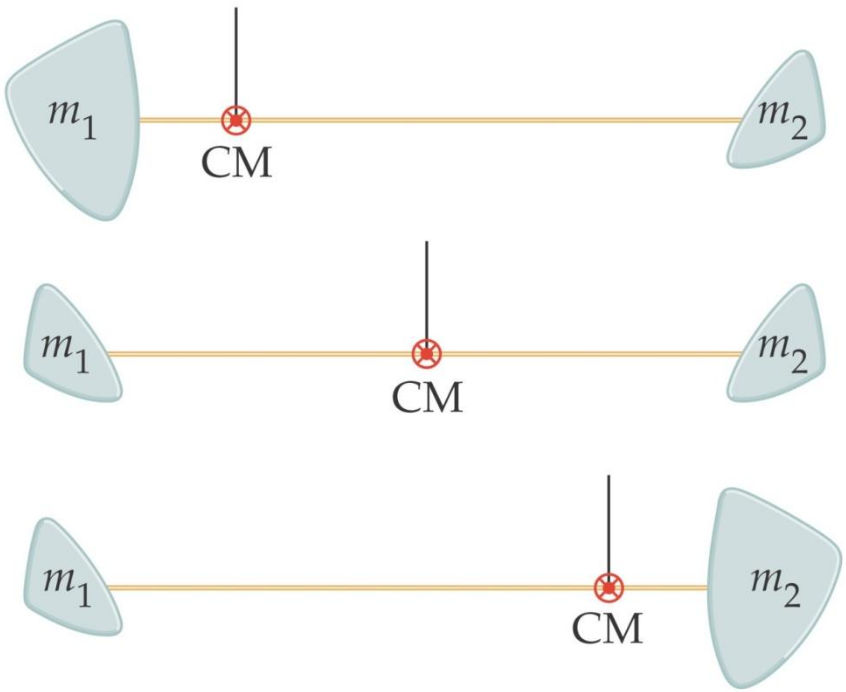
- L=6.0 m, M = 90 kg, D=1.5 m, m_{max}= ?



Why is the center of mass defined in that way?

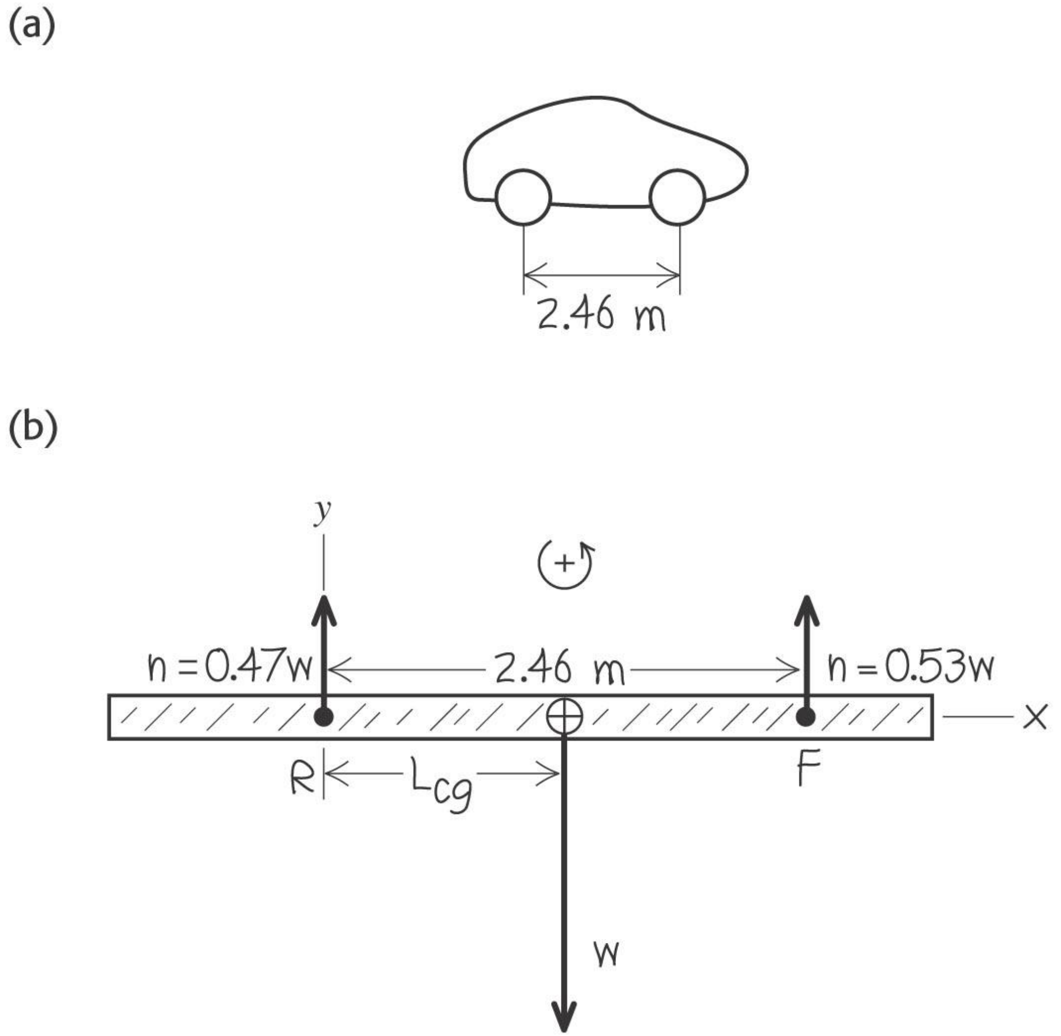
$$X_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{m_1 x_1 + m_2 x_2}{M}$$

Because $$m_1 g x_1 = -m_2 g x_2 \Rightarrow x_{cm} = 0$$



Solving rigid-body equilibrium problems

- n_1=0.47w, n_2=0.53w, L=2.46 m, L_{cg}=?



The ladder against a wall

- L = 5 m, w_1 = 800 N, w_2=180 N, α = 53.1°, n_1=? n_2=? f_s=? μ_s= ? Sum of n_2 and f_s?