

## Chapter 9: Static Equilibrium; Elasticity and Fracture

### Giancoli Text Sections

- 9-1 The Conditions for Equilibrium
- 9-2 Solving Statics Problems
- 9-4 Stability and Balance
- 9-5 Elasticity; Stress and Strain
- 9-6 Fracture

### Summary

This chapter treats static equilibrium, the case in mechanics when both the sum of the forces and the sum of the torques on an object are zero. The principles of static equilibrium are applied to signs and to balance i.e. *see-saws*. Stress, strain, and fracture are mentioned.

### Major Concepts

By the end of the chapter, you should understand each of the following and be able to demonstrate their understanding in problem applications as well as in conceptual situations.

- Conditions for static equilibrium
  - Sum of the forces = 0
  - Sum of the torques = 0
- Types of equilibrium
  - Stable
  - Unstable
  - Neutral
- Mechanical properties of solids (concept only)
  - Stress and strain
  - Fracture

## Formulas

FOR A SYSTEM (an object) IN EQUILIBRIUM, 2 CONDITIONS APPLY:

1.) All forces are in balance

$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

there is no NET force in the x or y (or z) direction for objects in equilibrium  
i.e. the object is not accelerating in any direction

AND

2.) CW torque = CCW torque i.e. there is no net torque on the system

$$\tau_{\text{CLOCKWISE}} = \tau_{\text{COUNTERCLOCKWISE}}$$

$$F_{\perp} r_{\text{CLOCKWISE}} = F_{\perp} r_{\text{COUNTERCLOCKWISE}} \quad \text{The lever arm "r" is always measured from the rotational point to the point of the applied force}$$

Remember, if there are multiple forces acting CW or CCW, you must account for all of them:

$$\tau_{\text{CLOCKWISE}} = \tau_{\text{COUNTERCLOCKWISE}}$$

$$F_{\perp 1} r_{1 \text{ CW}} + F_{\perp 2} r_{2 \text{ CW}} + \text{etc.} = F_{\perp 3} r_{3 \text{ CCW}} + F_{\perp 4} r_{4 \text{ CCW}} + \text{etc.}$$