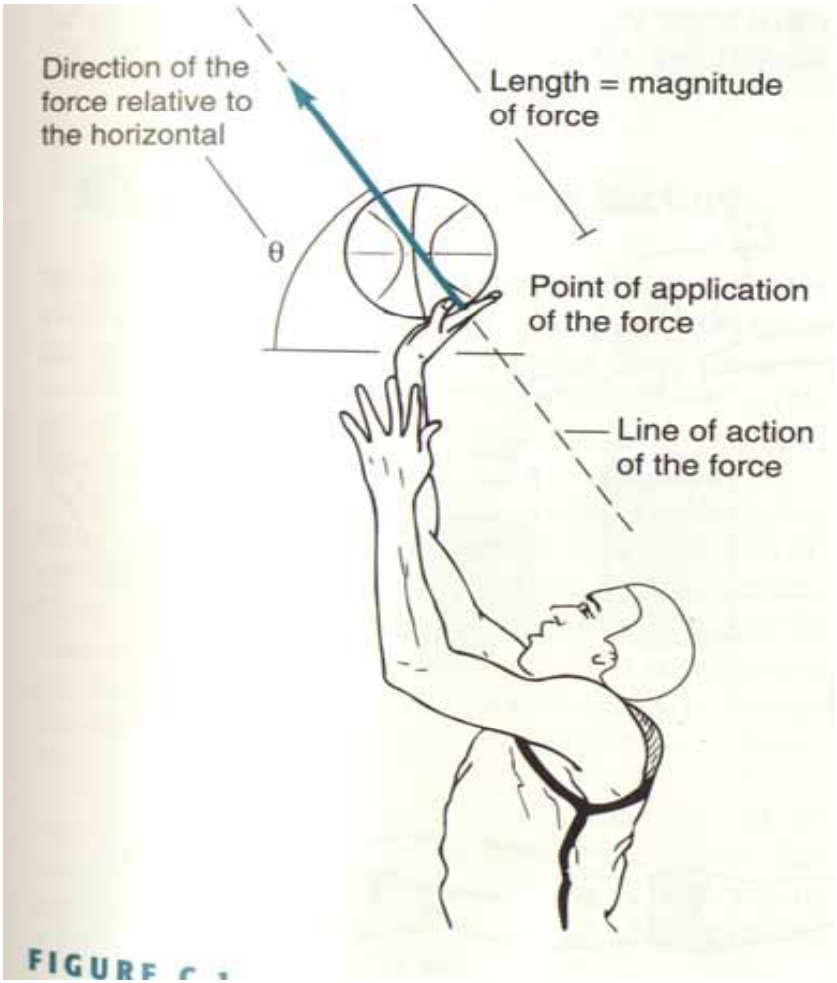
Section 4: Kinetics – Forces (Linear Velocities, Accelerations)

Four Properties of Force

- Magnitude
  - How much force
- Direction
  - The way the force is applied along action line
  - Gravity
  - Muscle
- Point of Application
  - Where force is applied
- Line of Application
  - Straight line extending through the point of application

From: Sterner

Four Properties of Force



FIGURE

From: Sterner

Mechanical Loads on the Body

- Compression
- Tension
- Shear
- Stress
  - Torsion
  - Bending
  - Combined Loads

From: Sterner

How is force calculated?

- Force = mass * acceleration
  - Mass is expressed in kilograms
  - Acceleration = $\frac{v_f - v_i}{t_f - t_i} = m/s^2$
  - Velocity = $\frac{\text{displacement}}{\text{change of time}} = \frac{\text{position2 - position 1}}{\text{time 2 - time 1}}$
- Units are in Newtons
  - 1N = $1 m/s^2$ in a body of 1 kg mass = kg * m/s^2

From: Sterner

Force vs Pressure

- Pressure = F/area
- Force acting over a given area
- Units = lbs/in^2 or N/m^2
- Ex.
  - Helmets
  - Joints

From: Sterner

Kinetics

- Joint reaction force – 3 times in single leg stance
- 5 times in walking
- Twice during SLR
- Up to 10 times while running

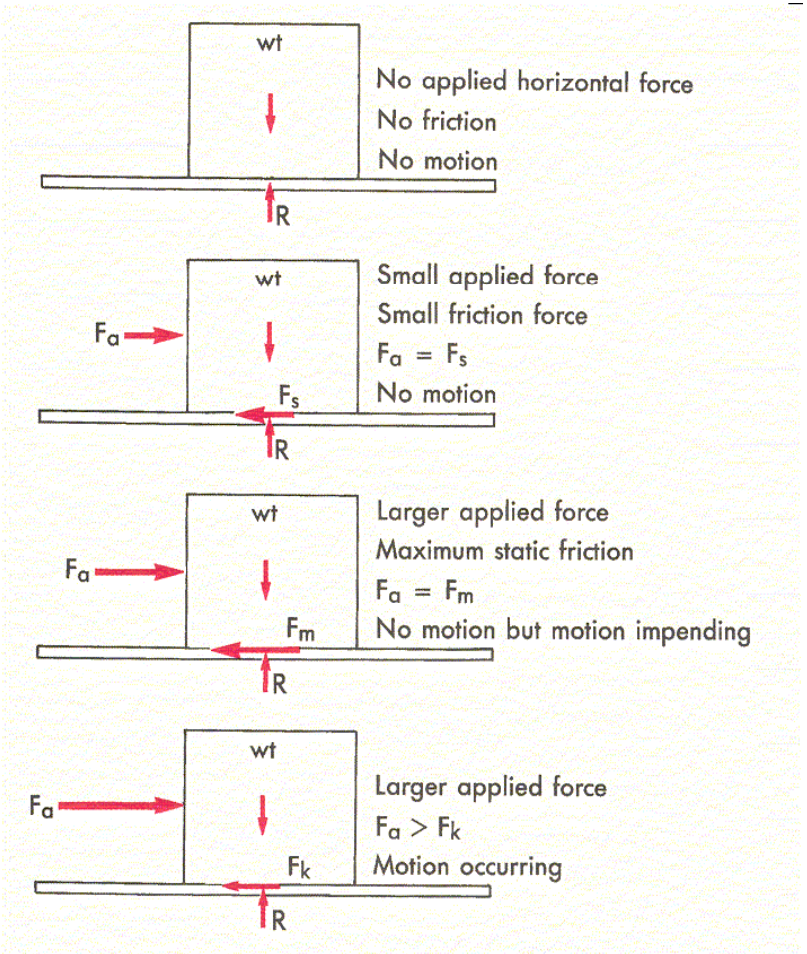
From: Bajekal

Center of Gravity

- Balance Point
- Conditions Needed
  - Linear forces
  - Rotary Forces
- Location
  - Men = 56% of height
  - Women = 55% of height
  - Height above crotch ~ 6 in.
- Stationary or Mobile?

From: Sterner

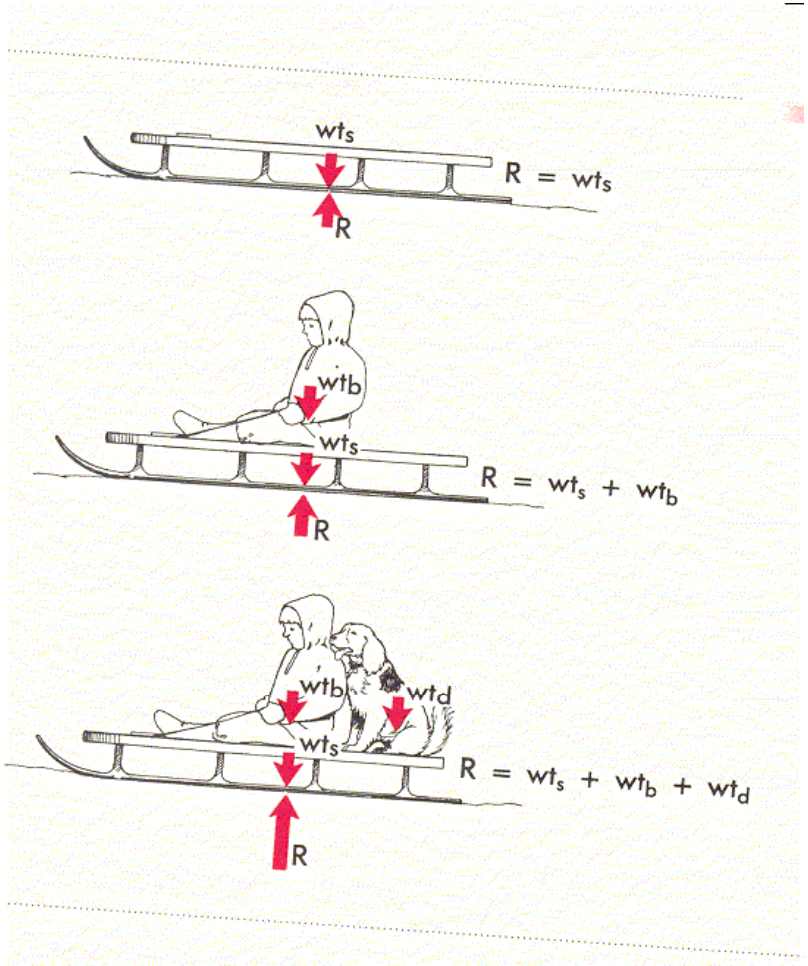
Friction

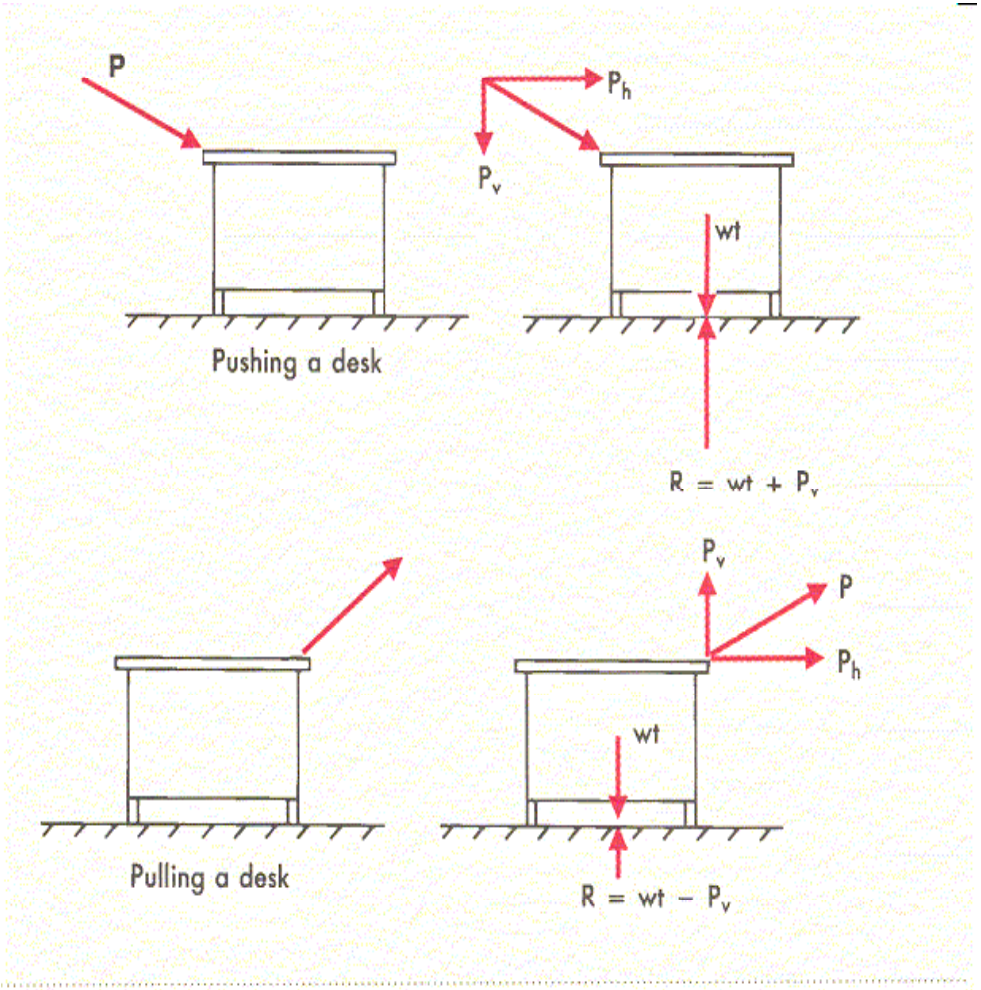


- Force that acts at the interface of surfaces in contact
- Occurs in the direction opposite the impending motion
- Static Friction
- Maximum Static Friction
- Kinetic (Sliding) Friction

From: Sterner

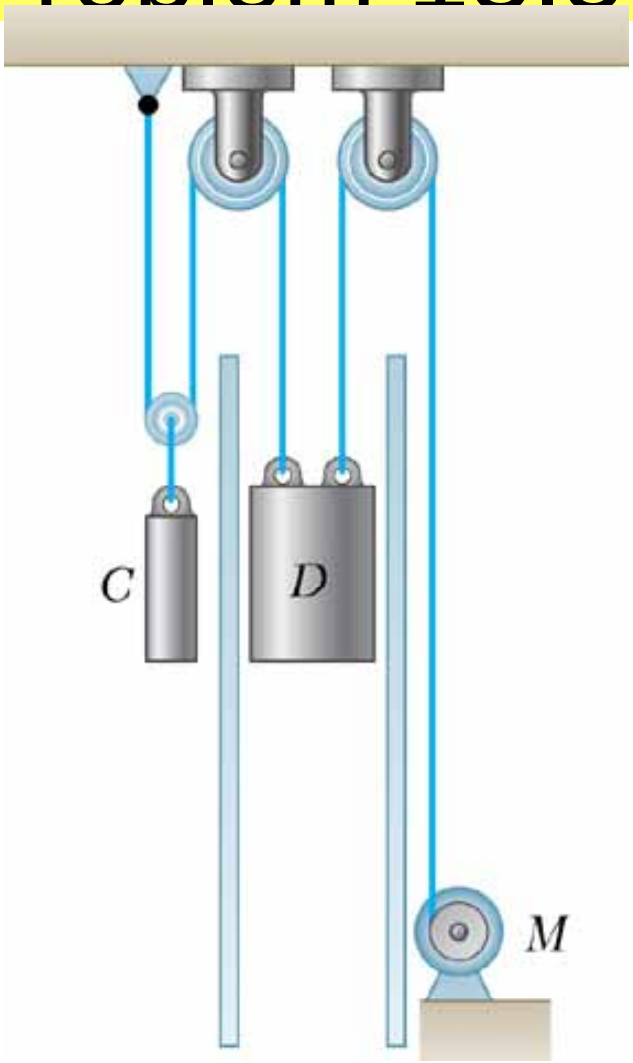
Examples of Altering Normal Reaction Force





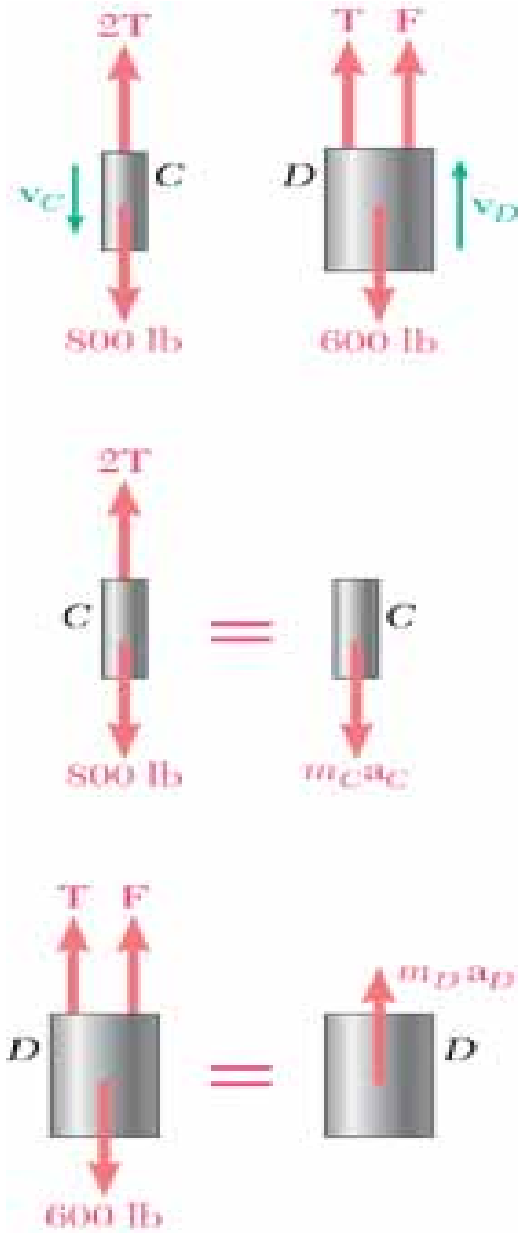
From: Sterner

Sample Problem 13.5



The dumbwaiter D and its load have a combined weight of 600 lb, while the counterweight C weighs 800 lb. Determine the power delivered by the electric motor M when the dumbwaiter (a) is moving up at a constant speed of 8 ft/s, (b) has an instantaneous velocity of 8 ft/s and an acceleration of 2.5 ft/s^2, both directed upward.

From: Jung



$$2T - 800 = 0$$

$$F + T - 600 = 0$$

$$Fv_D = 200lb * 8\,ft/s = 1600\,ft.lb/s$$

$$Power = 2.91hp$$

$$if \quad a_C = \frac{1}{2} a_D = 1.25$$

$$800 - 2T = ma_C = (800/32.2) * 1.25$$

$$F + T - 600 = (600/32.2) * 2.5$$

$$Fv_D = 262.1lb * 8\,ft/s = 2097\,ft.lb/s$$

$$Power = 3.81hp$$

From: Jung