Chapter 1_2

THE MECHANICS OF THE BODY

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Friction

- **Defin**

When two surfaces are in contact, their irregularities intermesh, and as a result there is a resistance to the sliding or moving of one surface on the other.

- frictional force depends
- **Force**
- **Nature of the surfaces**

- frictional force does not depend on the **size of the contact area**

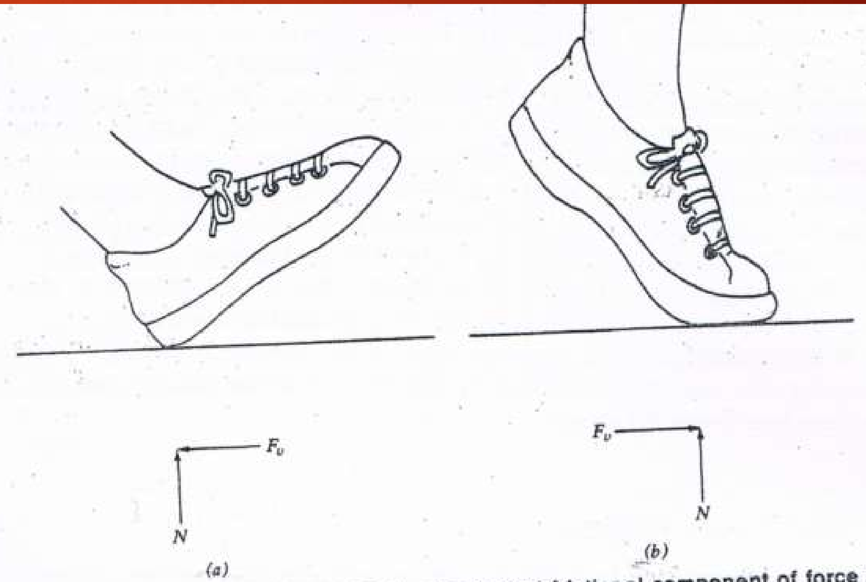


Figure 2.9. Normal walking. (*a*) Both a horizontal frictional component of force F_v and a vertical (normal) component of force *N* exist on the heel as it strikes the ground. Friction between the heel and surface prevents the foot from slipping forward. (*b*) When the foot leaves the ground the frictional component of force F_v prevents the toe from slipping backward. (Adapted from Williams, M., and Lissner, H.R., *Biomechanics of Human Motion*, Philadelphia, W.B. Saunders Company, 1962, p. 122, by permission.)

The frictional force F_f is given by

$$F_f = \mu F_n$$

μ is the coefficient of fraction between the two surface.

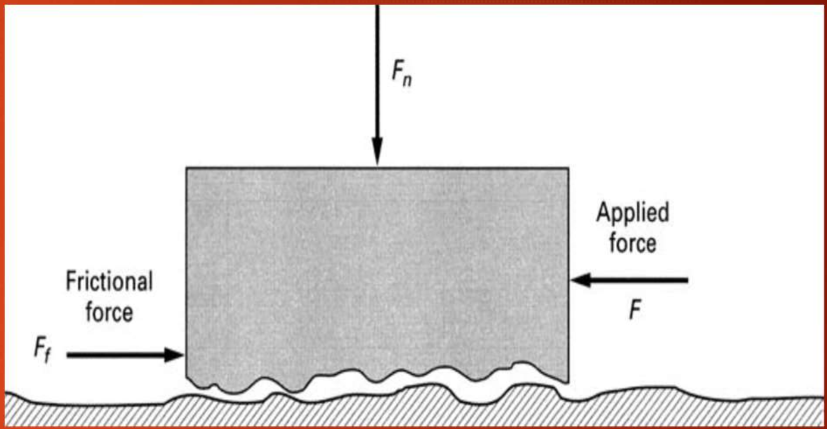
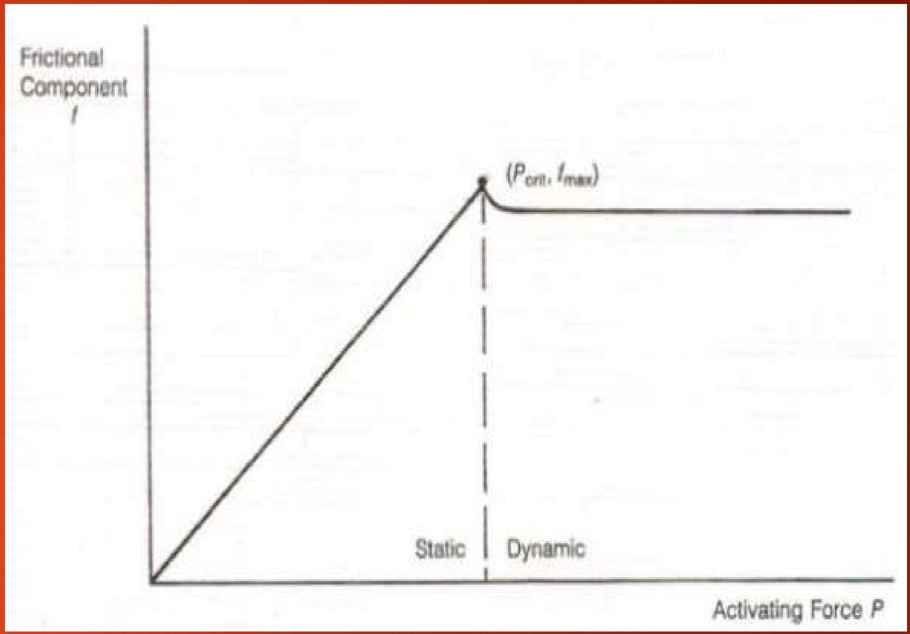


TABLE Coefficients of Friction, Static (μs) and Kinetic (μk)

Surfaces	μ_s	μ_k
Leather on oak	0.6	0.5
Rubber on dry concrete	0.9	0.7
Steel on ice	0.02	0.01
Dry bone on bone		0.3
Bone on joint, lubricated	0.01	0.003
Human joints (lubricated with synovial fluid)	0.005	0.005



The coefficient of fraction

- The coefficient of fraction in bone joints is usually much lower than the engineering type material.
- Synovial fluid in the joint is involved in the lubrication.
- An example of the importance of friction in dentistry lies in the concept of roughening the surface of a dental implant to reduce motion between the implant and adjacent tissue. It is perceived that a rough surface and resultant less motion will provide for better osseointegration. Friction is also important in sliding mechanics used in the orthodontic movement of teeth. The saliva we add when we chew food acts as a lubricant. If you swallow a piece of dry toast you become painfully aware of this lack of lubricant.

Example: 1
Acceleration a can be caused by leg muscle force F

- **Deceleration** can be caused by friction, muscle force or external forces

For a walker of $\boldsymbol{F_n} \approx$ W ≈ 800 N (m=82kg):

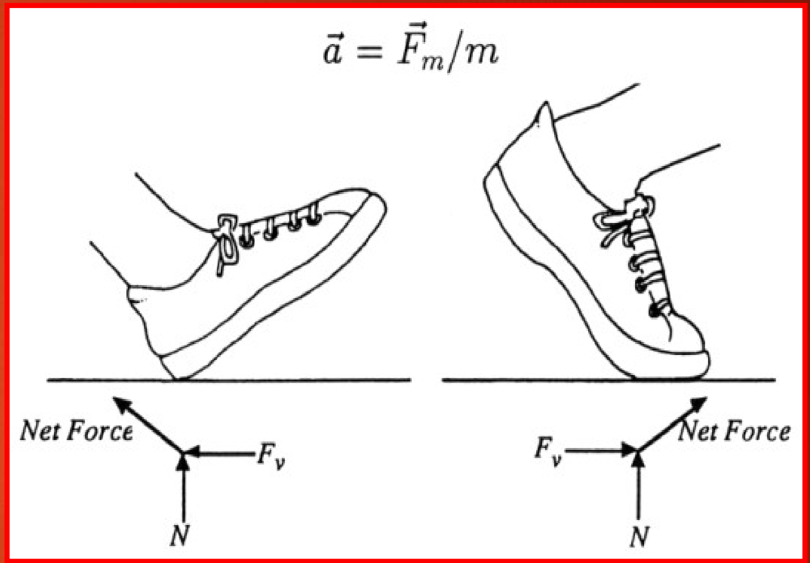
Friction force:

$$\boldsymbol{F_f} = \boldsymbol{\mu}W = 0.8 \times 800$$

$$F_f \approx 640 \text{ N}$$

$$F = a\,m$$

Deceleration: $a = \frac{F_f}{m} \approx 7.8 \ {}^{m}/_{s^2}$



Example 2:
Standing at an Incline

- The force F_n normal to the inclined surface is

$$F_n = W\ cos\theta$$

- The static frictional force F_f is

$$F_f = \mu F_n = \mu \times W\ cos\theta = 0.6 \times\ W\ cos\theta$$

- The force parallel to the surface F_p, which tends to cause the sliding, is

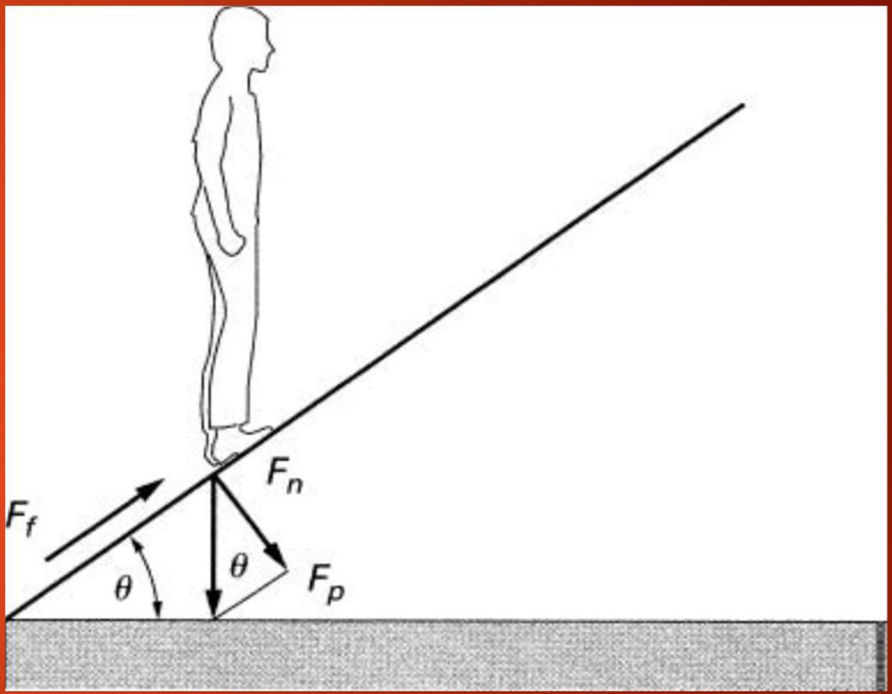
$$F_p = W\ sin\theta$$

- The person will slide when the force Fp is greater than the frictional force Ff ; that is, $Fp > Ff$
- At the onset of sliding, these two forces are just equal; therefore,

$$F_f = F_p : \quad 0.6\ W\ cos\theta = W\ sin\theta$$

$$\frac{sin\theta}{cos\theta} = tan\theta = 0.6$$

- Therefore $\theta = 31^\circ$.



Dynamic forces:

- Newton's second law:

$$A = \frac{F}{m}$$

$$F = a\,m\;(a = \Delta v/\Delta t)$$

$$F = m\frac{\Delta v}{\Delta t}$$

- Accelerations can produce a number of effects such as

1. An apparent increase or decrease in body weight
2. Change in internal hydrostatic pressure
3. Distortion of the elastic tissues of the body
4. The tendency of solids with different densities suspended in a liquid separate