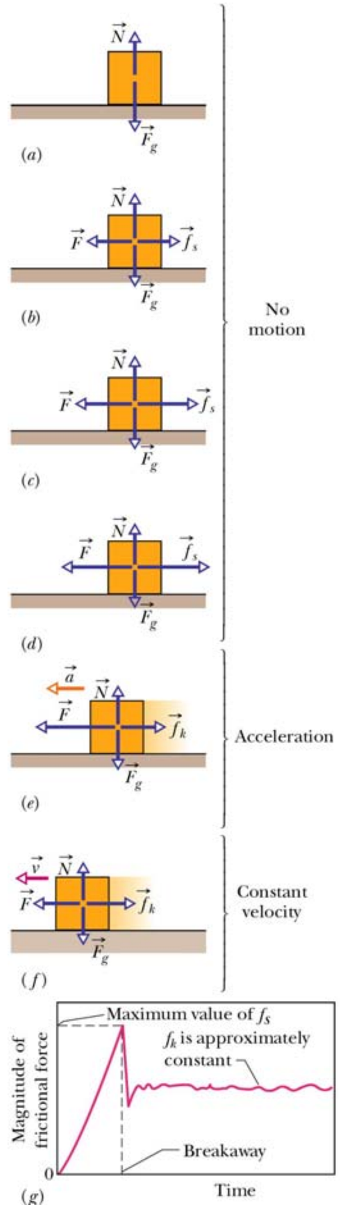
1. Friction

- A force is applied to a body resting on a surface but it does not move yet; a friction force of the same magnitude but opposite in direction keeps the body from moving – static frictional force f_s.

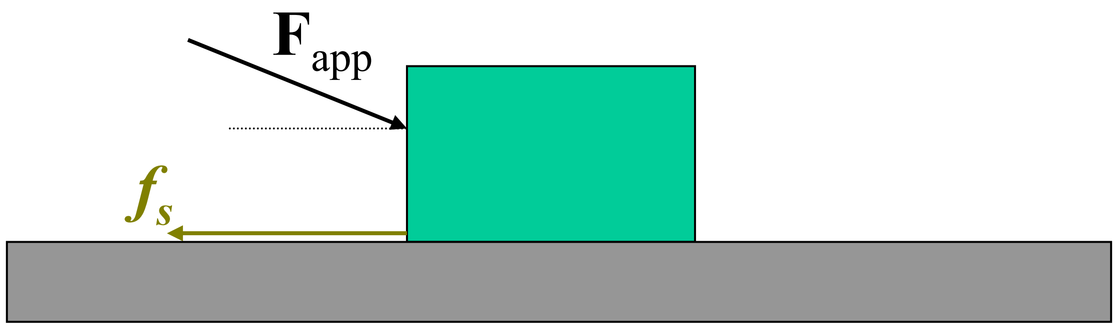
- As the applied force is increased, f_s reaches its maximum beyond which it cannot increase; the body starts to move as the applied force becomes greater than the friction.The friction that is now present (a constant value) is called the kinetic frictional force, f_k.



No motion
Acceleration
Constant velocity
(a)
(b)
(c)
(d)
(e)
(f)
(g)
Maximum value of f_s
f_k is approximately constant
Breakaway
Magnitude of frictional force
Time
0

2. Properties of Friction

- Static friction: the body does not move

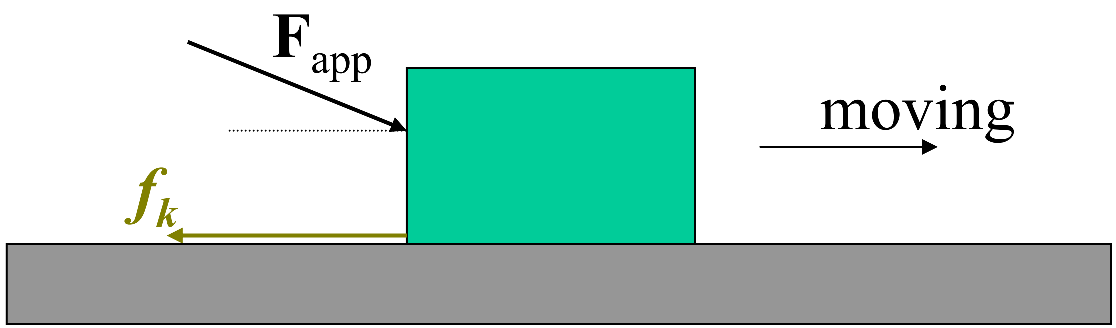


- $f_s = F_{app,x}$ (horizontal component of F_{app}) until it reaches the maximum value $f_{s,max} = \mu_s N$

μ_s=coefficient of static friction

N = Normal force on the body from the surface

- Kinetic friction: the body moves



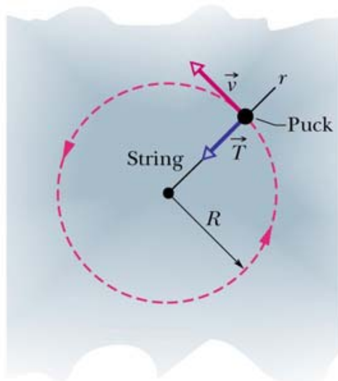
- $f_k = \mu_k N$

  μ_k=coefficient of kinetic friction
  N = Normal force on the body from the surface

- μ_s and μ_k are dimensionless and depend on certain properties of both the body and the surface.

4. Uniform Circular Motion and Force

example: A hockey puck of mass $\boldsymbol{m}$ tied to a string moving in a circular path of radius $\boldsymbol{R}$ on a horizontal frictionless surface.



Apply Newton's 2nd Law along the radial direction (directed toward the center):

$$\underbrace{\sum F_r}_{\downarrow} = m \underbrace{a_r}_{\downarrow}$$

$$T = m \frac{v^2}{R}$$

For an object of mass $\boldsymbol{m}$ to move in a circle of radius $\boldsymbol{R}$ with a constant speed $\boldsymbol{v}$, there must be a net centripetal force (mass × centripetal acceleration) with the magnitude $\boldsymbol{m\, v^2/R}$ and directed along the radius toward the centre of the circle.

CP: In the example above, the tension $\boldsymbol{T}$ is the only force available to provide the centripetal force necessary to keep the object in circular motion. Why don't the other forces acting on the puck (namely the gravitational force F_g and the normal force N) contribute to the net centripetal force?