Lecture 23, Nov 4, 2021

Static Friction

- Friction of all kinds always opposes relative motion between two surfaces
- Static friction is a non-dissipative force; since the object does not move, no thermal energy is produced
- Static friction is always less than the net applied force
- Max static friction is proportional to the normal force by a friction coefficient $F_s = \mu_s F_n$; once this amount is exceeded the object will start moving and kinetic friction comes into effect
- Independent of contact area and velocity

Kinetic Friction

- (Kinetic) friction in general is a dissipative force that takes kinetic and/or potential energy to thermal energy; therefore it is irreversible
- Once the object starts sliding, static friction turns into kinetic friction
- Also proportional to the normal force by another coefficient μ_k, which is always less than μ_s
  - If the kinetic friction coefficient is greater than or equal to the static friction coefficient, then the object would stop sliding as soon as it starts sliding
- Once the object starts moving the force required it to keep moving decreases as the type of friction switches from static to kinetic

Decomposition of Friction

- Consider a block resting on a surface; the force of friction acts parallel to the surface and holds the block in place, and opposes the component of gravity that parallel and down the surface
- With these inclined plane problems, forces such as gravity should be broken down into a component parallel to the plane and another one normal to the plane; the normal forces are always in balanced, and the parallel forces are opposed by friction
  - The component of gravity down the plane is $\sin\theta$ and the component normal to the plane is $\cos\theta$; thus at $\theta = 0$ we have a flat plane, and all the force is normal to the plane, and as θ increases, the component of gravity down the ramp increases as $\sin\theta$ increases

Friction Example

- Example: Person jumping onto a slider with $m_p = m_s$, and friction between the person and the block but not between the block and the floor
  - To find the final velocity of the person-block system after the person stops sliding on the block, we can use conservation of momentum $m_p v_{pi} = (m_p + m_b)v_f \implies v_f = \frac{v_{pi}}{2}$
  - Kinetic energy follows now that we have the final velocity, so now we can find the change in kinetic energy
  - To find the distance that the person slides on the block, we can use $\Delta E_{th} = -\Delta K$ and $F_k = \mu_k m_p g$ so $d = \frac{\Delta E_{th}}{\mu_k m_p g}$