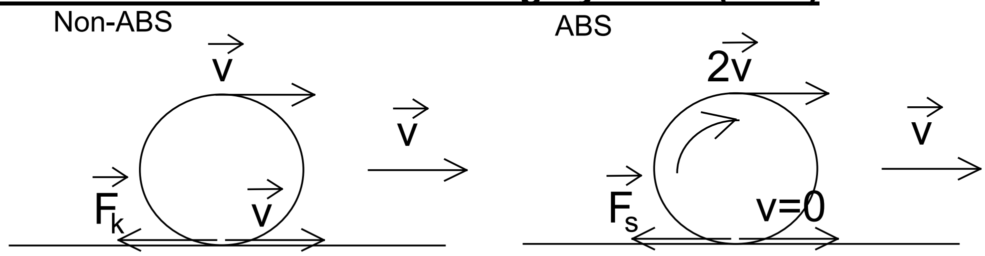
LECTURE #16 – SUMMARY

Application of Friction: Antilock Braking Systems (ABS)



- locked, skidding wheel
- all points move at same speed v
- kinetic friction between wheel and road

- rolling wheel
- bottom momentarily at rest
- static friction acts

Because $\mu_s > \mu_k$, the stopping distance is greater for the ABS case.

Centrifugal Force

= a fictitious force that arises in a rotating (i.e., non-inertial) reference frame.
Looked at several examples of how centrifugal forces arise.

Inertial vs. Gravitational Mass

Inertial mass is the scalar that appears in Newton's Second Law: $\vec{F}_{net} = m_{inertial}\vec{a}$.

Gravitational mass appears in Law of Universal Gravitation: $\vec{F}_{grav} = GM_{grav}m_{grav}/r^2$.

There is no reason why these masses should be equal, but experiments suggest they are to 1 part in 10^{12}. Einstein's Principle of Equivalence (1915): $m_{grav} = m_{inertial}$

Section III.6 Work, Energy, and Power

Kinetic Energy

Given a particle of mass m, travelling at speed v, its kinetic energy is $\boxed{K \equiv \frac{1}{2}mv^2}$.

- units $\rightarrow$ kg (m^2/s^2) = (kg m/s^2) m = N m = Joule (J)
- scalar quantity, always positive, a relative quantity - depends on v

Work-Energy Theorem for 3-D Constant Applied Force

Consider an object moving along some trajectory from $\vec{r}_i$ to $\vec{r}_f$, with $\vec{F}_{net}, \vec{a}$ constant. We applied the equations for $\vec{r}_i$, $\vec{r}_f$, $\vec{v}_i$, $\vec{v}_f$ in the x, y, z directions, eliminated time [e.g., $t_f - t_i = (v_{f,x} - v_{i,x})/a_x$], and used $\vec{a} = \vec{F}_{net}/m$ to get:

$$F_{net,x}(x_f - x_i) = \tfrac{1}{2}mv_{f,x}^2 - \tfrac{1}{2}mv_{i,x}^2$$

$$F_{net,y}(y_f - y_i) = \tfrac{1}{2}mv_{f,y}^2 - \tfrac{1}{2}mv_{i,y}^2 \qquad \text{Hence } \vec{F}_{net} \bullet (\vec{r}_f - \vec{r}_i) = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 .$$

$$F_{net,z}(z_f - z_i) = \tfrac{1}{2}mv_{f,z}^2 - \tfrac{1}{2}mv_{i,z}^2$$

Work-Energy Theorem for Constant (3-D) Force:

$$\boxed{\begin{aligned} \vec{F}_{net} \bullet \Delta\vec{r} &= \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 \\ \vec{F}_{net} \bullet \Delta\vec{r} &= K_f - K_i \end{aligned}}$$