CH6 Randall textbook ①

- **Equilibrium:** An object is at rest or moving in a straight line with constant velocity is in equilibrium. The net force is zero. $\vec{F}_{net} = 0$ and $\vec{a} = 0$

- **Mass:** is the amount of matter in an object. It is the same everywhere.

- **Weight:** is the result of weighing an object on a scale. It depends on gravity and acceleration.

- Static and kinetic friction dependens on the coefficient of friction but not on the object's speed.

- Drag depends on the square of the speed and also on the object's cross-section area.

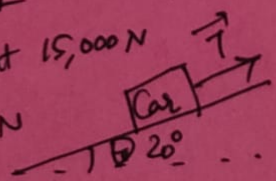
- Equilibrium Problems
  - write coordinate system
  - Identify what the problem is asking
  - Identify all forces acting on a free body diagram
  - $\vec{F}_{net} = \sum_i \vec{F}_i = 0$

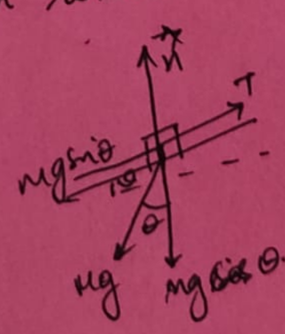
Applied only to objects which cannot rotate.

$$\begin{cases} (F_{net})_x = \sum_i (F_i)_x = 0 \\ (F_{net})_y = \sum_i (F_i)_y = 0 \end{cases}$$

example 6.2 Text Book

Car weight 15,000 N
$T = 6000$ N
will it hold?





since $(F_{net})_x = 0$, $(F_{net})_y = 0$

$T - mg\sin\theta = 0$

$n - mg\cos\theta = 0$

$T = mg\sin 20° = 15\times10^3 \sin 20°$

$= 5100$ N

Yes it will hold the car.

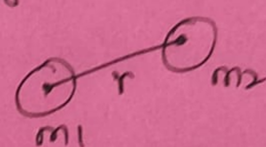
Dynamic Problems
- Establish coordinate system
- Identify what to find in the problem
- Draw free body diagram and show all forces acting on the object.

$$\vec{F}_{net} = m\,\vec{a}_{net} = \sum_i \vec{F}_i$$

$$(\vec{F}_{net})_x = m a_x = \sum_i (F_i)_x$$

$$(\vec{F}_{net})_y = m \cdot a_y = \sum_i (F_i)_y$$

Gravity : is an attractive, long range force between any two objects



$$\vec{F}_{1 on 2} = \vec{F}_{2 on 1} = \frac{G m_1 m_2}{r^2}$$

$G = 6.67 \times 10^{-11}\ N\,m^2/kg^2$

Called Gravitational Constant.

$$\vec{F}_G = \vec{F}_{planet\ on\ m} = \frac{GMm}{R^2} = mg$$

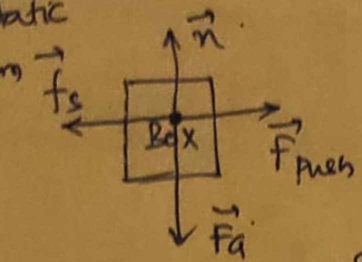
$$\boxed{g = \frac{GM}{R^2}}$$

Friction

without friction we canot walk, drive

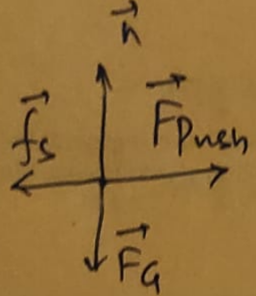
Static friction: $\vec{f_s}$ is the force on an object that keeps it from slipping.

Box in static equilibrium $\vec{f_s}$



$|\vec{f_s}| = |\vec{F}_{push}|$ Static frictional force is balancing the pushing force

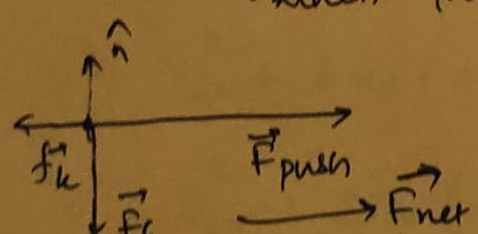
- Static friction force $\vec{f_s}$ points in the opposite direction to prevent the motion.



- $f_{s\,max}$ the static friction force maximum
  - if $f_s < f_{s\,max}$ object remains at rest
  - $f_s = f_{s\,max}$ object slips
  - $f_s > f_{s\,max}$ not physically possible.

- $f_{s\,max} = \mu_s n$ ie; $f_{s\,max}$ is Proportional to magnitude of normal force.
  (μ_s → Coefficient of static friction.)

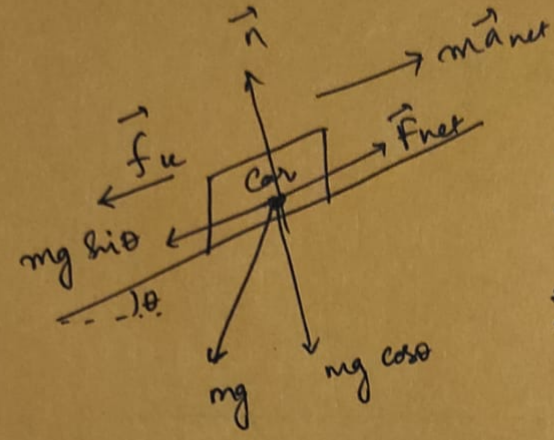
- Kinetic friction: The direction of $\vec{f_k}$ is always opposite to the direction in which an object slides across the surface



$f_k = \mu_k n$ (μ_k – Coefficient of kinetic friction)

$f_k < f_{s\,max}$.

- Rolling friction. $f_r = \mu_r n$ (μ_r – coefficient of rolling friction)



$$\sum_i \vec{F}_i = \vec{F}_{net} = m\vec{a}_{net}$$

$$\sum_i (F_i)_x = m a_x$$

$$\sum_i (F_i)_y = m a_y$$

$$-mg\sin\theta - f_k = m a_x$$

$$n - mg\cos\theta = m a_y = 0 \Rightarrow n = mg\cos\theta$$

$$m a_x = -f_k - mg\sin\theta$$

$$= -\mu_k n - mg\sin\theta$$

$$+m a_x = -\mu_k mg\cos\theta - mg\sin\theta$$

$$a_x = -g(\mu_k\cos\theta + \sin\theta)$$

$$v_{fx}^2 = v_{ix}^2 + 2a_x(x_f - x_i)$$

$$0 = v_{ix}^2 + 2a_x(\Delta x) \Rightarrow \Delta x = \frac{-v_{ix}^2}{2a_x}$$

$$\Delta x = \frac{+v_{ix}^2}{+g(\mu_k\cos\theta + \sin\theta)} = \frac{v_{ix}^2}{g(\mu_k\cos\theta + \sin\theta)}$$