Topic 3B: Frictional Forces, Spring Force, Circular Motion and Universal Gravitation

Skill 23: Coefficient of Friction

Force of friction (F_f) always opposes motion

The force to start an object moving (static friction) is always greater than the force required to keep an object moving

The force of Friction depends on

- Magnitude of Normal Force: For level surface $\theta = 0°$ & $\cos 0° = 1$ so $F_N = F_g = mg$
  For inclined plane (ramp) $\theta \neq 0$ so $F_N = F_{g\perp} = F_g \cos\theta = mg\cos\theta$
- types of surfaces in contact due to microscopic structure
  each combination is assigned a coefficient of friction μ
  - For object starting from rest, use coefficient of static friction μ_s } static = start
  - For object already in motion, use coefficient of kinetic friction μ_k } kinetic = keep

(Surface Area & magnitude of speed do not matter) $\mu_s > \mu_k$

Equation: $F_f = \mu F_N$

Force of Static friction $F_f = \mu_s F_N$

Force of Kinetic $F_f = \mu_k F_N$

$\mu_{s\ or\ k} = \frac{F_f}{F_N}$

μ is unitless Scalar quantity

To Find F_f from old method

$F_f = F_{Ax}$ for an object at rest or constant speed on a horizontal surface

$ma = F_{Ax} + F_f$ for an object that is speeding up, slowing down changing direction

For inclined plane $F_{net\parallel} = F_{g\parallel} + F_A + F_f$

Coefficients shown on PRT are less than 1 but can be greater. That would mean the object is easier to lift than push. $\mu_s > 1$

It also means an object on an incline remains at rest for angles greater than 45°

$F_f = \mu F_N$ $\mu = \frac{F_f}{F_N} = \frac{F_{g\parallel}}{F_{g\perp}} = \frac{mg\sin\theta}{mg\cos\theta} = \tan\theta$

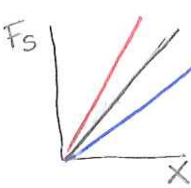
Skill 24: Spring Forces

Spring Force is a measure of how much force is required to stretch or compress a spring

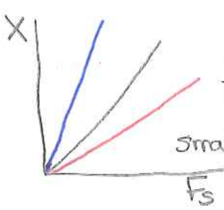
$F_s = kx$ also known as Hooke's Law

k: is spring constant

x: is change in length from equilibrium



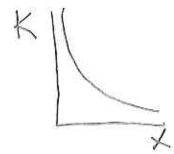
$k = \frac{F_s}{x}$



$\frac{x}{F_s} = \frac{1}{k}$ you must flip to get k

smallest slope = greatest k

- a low "k" means easy to stretch
- a high "k" means difficult to stretch



$k = \frac{F_s}{x}$ If you apply the same force to a variety of springs, the greatest stretch will occur at the lowest k

k & x are inverse

For a mass applied vertically to a spring the gravitational field exerts the force of weight on the spring. Therefore,

$F_s = F_g$

so

$kx = mg$

This is how a spring scale at the grocery store works.