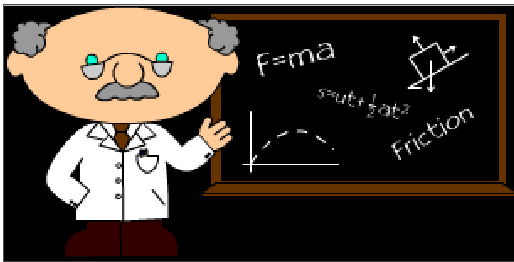
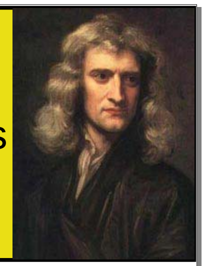


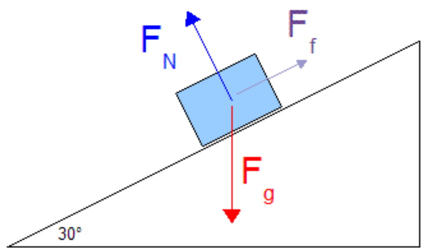
Unit 2: Dynamics



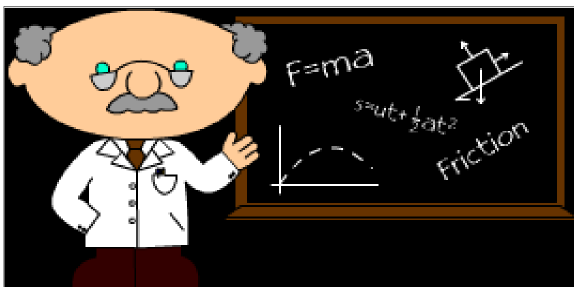
2.8 Inclined Planes

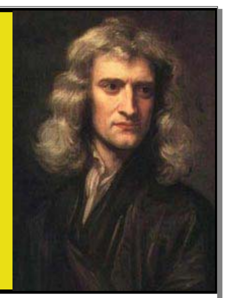
In Trigonometry we studied a little ol' thing called SOH CAH TOA. When analyzing the effects of static and kinetic friction, inclined planes are a good place to start.

What forces act on a box sitting on an inclined plane?



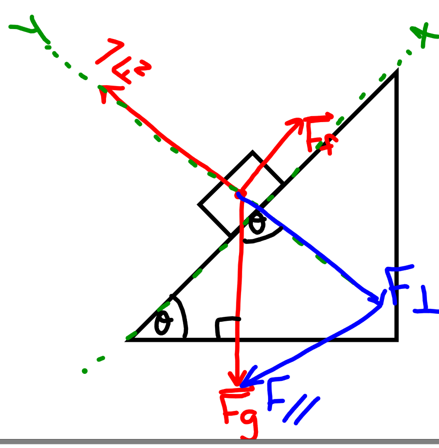
Things aren't really balancing here because we know that *forces occur in pairs (Newton's Third Law).*





Let's look at a more balanced free-body diagram:

⊥ // "to the surface"



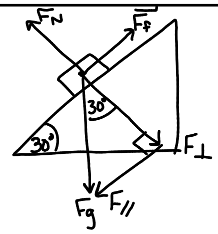
$\vec{F}_{\parallel} = -\vec{F}_f$

$\vec{F}_{\perp} = -\vec{F}_N$

Ex.) A box weighing 562 N is on an incline of 30°. Find each force acting on the box. (Hint: The direction of the box is "down the ramp.") F_f up

$\vec{F_g} = -562\text{ N}$

Steps:
1. Draw the free-body diagram.
2. Calculate the parallel and perpendicular forces using Trig.



$\sin 30° = \frac{F_{//}}{F_g}$ $F_{//} = mg\sin\theta$

$= -562\sin 30° = \boxed{-281\text{N}}$

$\Rightarrow F_f = \boxed{281\text{N}}$

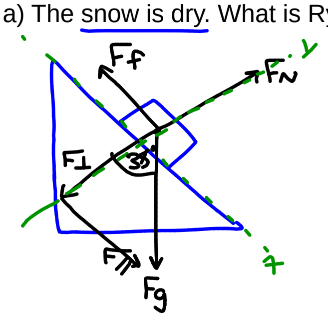
$\cos 30° = \frac{F_\perp}{mg}$ $F_\perp = mg\cos\theta$

$= -562\cos 30°$

$= \boxed{-487\text{ N}} \Rightarrow F_N = \boxed{487\text{N}}$

Ex.) Ryan (mass = 70 kg) has a hickory snowboard and is snowboarding down an incline of 38°. $\mu = 0.04$ Kinetic

a) The snow is dry. What is Ryan's acceleration?



$\sin 38° = \frac{F_{//}}{F_g}$

$\vec{F}_{net_x} = \vec{F_f} + \vec{F_{//}}$

$m\vec{a} = \mu F_N + mg\sin\theta$

$\frac{m\vec{a}}{m} = \frac{\mu(mg\cos\theta) + mg\sin\theta}{m}$

$\vec{a} = -\mu g\cos 38° + g\sin 38°$

$\vec{a} = (-0.04)(-9.81)(\cos 38°) + (-9.81)\sin 38°$

$\boxed{\vec{a} = 5.7\text{ m/s}^2\text{ [downhill]}}$

b) The snow melts a little bit and becomes wet, what is the new acceleration?

$\mu = 0.14$ $\quad \vec{a} = -\mu \vec{g}\cos\theta + \vec{g}\sin\theta$

$= (-0.14)(-9.81)\cos 38^\circ + (-9.81)(\sin 38^\circ)$

$= \boxed{5.0\ m/s^2\ [\text{downhill}]}$

c) What coefficient due to static friction is needed to keep Ryan at rest?

$F_{net_x} = F_{\parallel} + F_f$ $\quad$ not moving $\Rightarrow F_{net_x} = 0\,N$

$0 = mg\sin\theta + \mu F_N$

$0 = mg\sin\theta + \mu(-mg\cos\theta)$

$0 = mg\sin\theta - \mu mg\cos\theta$

$+\mu mg\cos\theta \qquad +\mu mg\cos\theta$

$\frac{\mu mg\cos\theta}{mg\cos\theta} = \frac{mg\sin\theta}{mg\cos\theta}$

$\mu = \tan\theta = \tan 38^\circ = \boxed{0.78}$

Ex. 3.14, 3.15, Practice Problems 1 and 2(Pg. 175), 3.16, Practice Problems 1 and 2(Pg. 179), 3.17, Practice Problems 1 and 2(Pg. 185), 3.18, Practice Problems 1 and 2(Pg. 186)(Optional), 3.19, Practice Problems 1 and 2(Pg. 188)

Pg. 190 # 4-6, 8-10. 7


F=ma
Friction