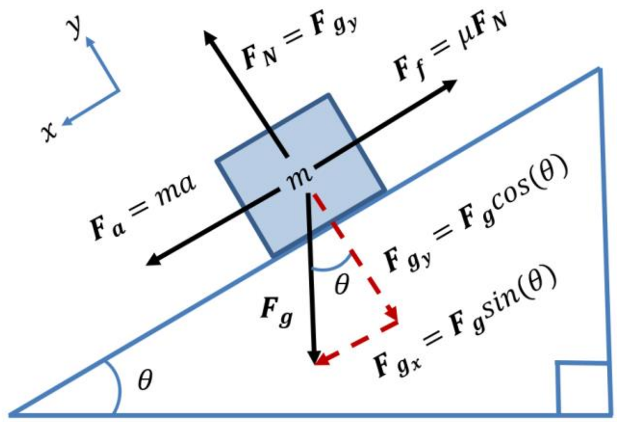
Harold's Physics of Forces
"Cheat Sheet"

19 April 2016

The Classic Force on an Incline Problem

Diagram



Givens	$m = 100\ kg$ Mass $\theta = 30^{\circ}$ Degrees inclined from horizontal		
	$v = 0$	$v = constant$	$a = constant$
	$\mu_s = 0.30$ Static coefficient of friction (not moving) (0,1]	$\mu_k =$ Kinetic coefficient of friction (moving) [0, 1)	$\mu_k = 0.20$
Unknowns	$F_{f_s} =$ ______ N	$\mu_k =$ ______	$a =$ ______ $^{m}/_{s^2}$
Observations	$g = 9.8\ ^{m}/_{s^2}$		
Equations	$\sum F_y = F_N - F_{g_y} = 0$	$\sum F_x = F_{g_x} - F_{f_k} = 0$	$\sum F_x = F_{g_x} - F_{f_k} = F_a$
	Since $v = 0$: $F_{g_x} < F_{f_s}$	Since $v = constant$: $F_{g_x} = F_{f_k}$	Since $a = constant$: $F_a = F_{g_x} - F_{f_k}$
Solve	$F_g = mg$ $F_N = F_{g_y}$ $F_N = F_g \cos(\theta) = mg\cos(\theta)$ $F_{g_x} < F_{f_s\,max}$ $F_{g_x} = F_g \sin(\theta) = mg\sin(\theta)$ $F_{f_s} = \mu_s F_N = \mu_s mg\cos(\theta)$	$F_{g_x} = F_{f_k}$ $F_{g_x} = F_g \sin(\theta) = mg\sin(\theta)$ $F_{f_k} = \mu_k F_{g_y} = \mu_k mg\cos(\theta)$ $mg\sin(\theta) = \mu_k mg\cos(\theta)$ $\mu_k = \tan(\theta)$	$F_a = ma$ $F_{g_x} = F_g \sin(\theta) = mg\sin(\theta)$ $F_{f_k} = \mu_k F_N = \mu_k mg\cos(\theta)$ $F_a = F_{g_x} - F_{f_k}$ ma $= mg\sin(\theta) - \mu_k mg\cos(\theta)$ $a = g\,[\sin(\theta) - \mu_k\cos(\theta)]$
Substitute	$F_{g_x} = (100)(9.8)\sin(30^{\circ})$ $= 490\ N$ $F_{f_s\,max}$ $= (0.30)(100)(9.8)\cos(30^{\circ})$ $= 509\ N$	$\mu_k = \tan(30^{\circ}) = 0.577$	a $= (9.8)[\sin(30^{\circ})$ $- (0.20)\cos(30^{\circ})] = 3.2\ ^{m}/_{s^2}$
Box & Check Your Answer	$\boxed{F_{f_s} = 490\ N}$ $490\ N < 509\ N$ ✓	$\boxed{\mu_k = 0.577}$ $0.577 < 1.0$ ✓	$\boxed{a = 3.2\ ^{m}/_{s^2}}$