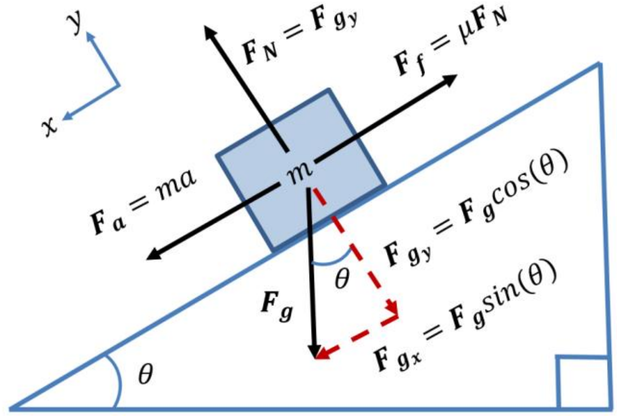
Harold's Physics Forces on an Incline
Cheat Sheet

3 November 2025

The Classic Force on an Incline Problem

Diagram			
Scenario	$\boldsymbol{v} = 0$	$\boldsymbol{v} = constant$	$\boldsymbol{a} = constant$
Givens	$m = 100\ kg$ $\theta = 30^\circ$ inclined from the horizontal		
	$\mu_s = 0.30$ $\mu_s =$ Static coefficient of friction (not moving) (0,1]	$\mu_k = 0.20$ $\mu_k =$ Kinetic coefficient of friction (moving) [0, 1)	
Unknowns	$\boldsymbol{F}_{f_s} =$ _____ N	$\mu_k =$ _____	$\boldsymbol{a} =$ _____ $m/_{s^2}$
Observations	$g = 9.8\ m/_{s^2}$		
Equations	$\sum \boldsymbol{F}_y = \boldsymbol{F}_N - \boldsymbol{F}_{g_y} = 0$	$\sum \boldsymbol{F}_x = \boldsymbol{F}_{g_x} - \boldsymbol{F}_{f_k} = 0$	$\sum \boldsymbol{F}_x = \boldsymbol{F}_{g_x} - \boldsymbol{F}_{f_k} = \boldsymbol{F}_a$
	Since $\boldsymbol{v} = 0$: $\boldsymbol{F}_{g_x} < \boldsymbol{F}_{f_s}$	Since $\boldsymbol{v} = constant$: $\boldsymbol{F}_{g_x} = \boldsymbol{F}_{f_k}$	Since $\boldsymbol{a} = constant$: $\boldsymbol{F}_a = \boldsymbol{F}_{g_x} - \boldsymbol{F}_{f_k}$
Solve	$\boldsymbol{F}_g = m\boldsymbol{g}$ $\boldsymbol{F}_N = \boldsymbol{F}_{g_y}$ $\boldsymbol{F}_N = \boldsymbol{F}_g \cos(\theta) = m\boldsymbol{g} \cos(\theta)$ $\boldsymbol{F}_{g_x} < \boldsymbol{F}_{f_s\,max}$ $\boldsymbol{F}_{g_x} = \boldsymbol{F}_g \sin(\theta) = m\boldsymbol{g} \sin(\theta)$ $\boldsymbol{F}_{f_s} = \mu_s \boldsymbol{F}_N = \mu_s m\boldsymbol{g} \cos(\theta)$	$\boldsymbol{F}_{g_x} = \boldsymbol{F}_{f_k}$ $\boldsymbol{F}_{g_x} = \boldsymbol{F}_g \sin(\theta)$ $= m\boldsymbol{g} \sin(\theta)$ $\boldsymbol{F}_{f_k} = \mu_k \boldsymbol{F}_{g_y}$ $= \mu_k m\boldsymbol{g} \cos(\theta)$ $m\boldsymbol{g} \sin(\theta) = \mu_k m\boldsymbol{g} \cos(\theta)$ $\mu_k = \tan(\theta)$	$\boldsymbol{F}_a = ma$ $\boldsymbol{F}_{g_x} = \boldsymbol{F}_g \sin(\theta) = m\boldsymbol{g} \sin(\theta)$ $\boldsymbol{F}_{f_k} = \mu_k \boldsymbol{F}_N = \mu_k m\boldsymbol{g} \cos(\theta)$ $\boldsymbol{F}_a = \boldsymbol{F}_{g_x} - \boldsymbol{F}_{f_k}$ $m\boldsymbol{a}$ $= m\boldsymbol{g} \sin(\theta) - \mu_k m\boldsymbol{g} \cos(\theta)$ $\boldsymbol{a} = \boldsymbol{g}\,[\sin(\theta) - \mu_k \cos(\theta)]$
Substitute	$\boldsymbol{F}_{g_x} = (100)(9.8)\sin(30^\circ)$ $= 490\ N$ $\boldsymbol{F}_{f_s\,max}$ $= (0.30)(100)(9.8)\cos(30^\circ)$ $= 509\ N$	$\mu_k = \tan(30^\circ) = 0.577$	$\boldsymbol{a}$ $= (9.8)[\sin(30^\circ)$ $- (0.20)\cos(30^\circ)] = 3.2\ m/_{s^2}$
Box & Check Your Answer	$\boxed{F_{f_s} = 490\ N}$ $490\ N < 509\ N$ ✓	$\boxed{\mu_k = 0.577}$ $0.577 < 1.0$ ✓	$\boxed{a = 3.2\ m/_{s^2}}$