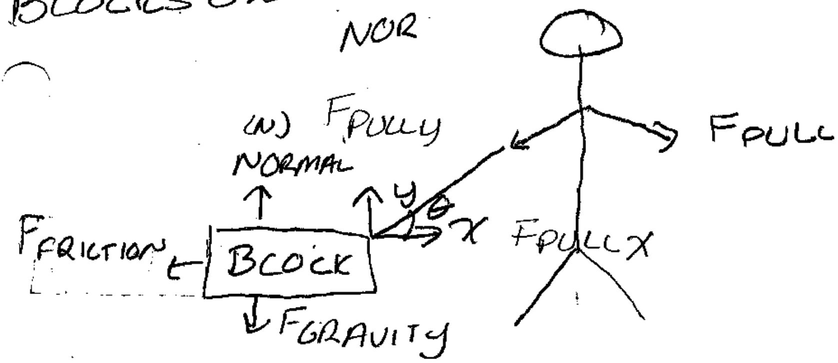
3/28/2018 LECTURE NOTES

BLOCKS ON A LEVEL SURFACE

NOR



$a_x = 0.00\ m/s^2$

$a_y = a$

$F_{PULLy} = F_{PULL}\sin\theta = N$

$F_{PULLx} = F_{PULL}\cos\theta$

FOR μ_s (COEFFICENT OF STATIC FRICTION) $a = 0.00\ m/s$

$F_f = \mu_s N$

FOR μ_k (COEFFICENT OF KINETIC FRICTION) $a = a$

$F_f = \mu_k N$

$\Sigma F_y = \overset{(N)}{F_{PULLy}} - F_{GRAVITY} = 0$

$\Sigma F_x = F_{PULLx} - F_{FRICTION} = ma$

$N - F_{GRAVITY} = 0 \Rightarrow N = F_{GRAVITY} = mg$

$F_{PULLx} - FRICTION = ma$

$F_{PULL}\cos\theta - \mu_k N = ma - F_{PULL}\cos\theta$

$-F_{PULL}\cos\theta$

$+\mu_k N = -ma + F_{PULL}\cos\theta$

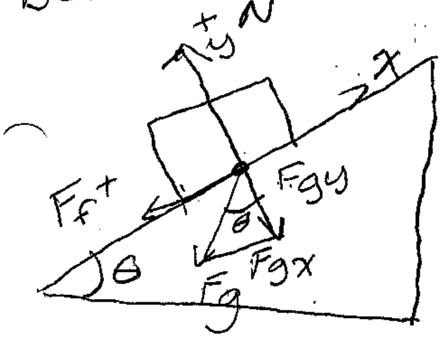
$\mu_k N = F_{PULL}\cos\theta + ma$

$\frac{\mu_k mg}{mg} = \frac{F_{PULL}\cos\theta - ma}{mg}$

$\boxed{\mu_k = \frac{F_{PULL}\cos\theta - ma}{mg}}$

$\boxed{\mu_s = \frac{F_{PULL}\cos\theta}{mg}}$

BLOCKS ON A INCLINE



$$g_y = g\cos\theta$$
$$g_x = g\sin\theta$$
$$F_f = \mu_k N$$

$$\Sigma F_y = N - mg_y = 0$$
$$\Sigma F_x = F_f - mg_x = -ma$$

$$N - mg_y = 0 \Rightarrow N = mg_y = mg\cos\theta$$

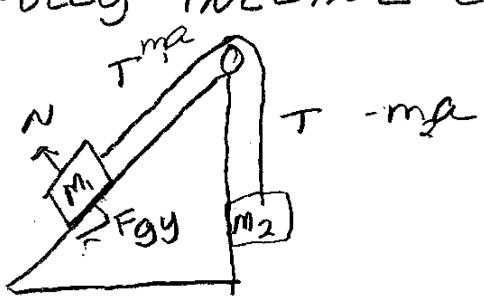
$$\mu_k N - mg\sin\theta = -ma$$
$$\mu_k \cancel{m}g\cos\theta - \cancel{m}g\sin\theta = -\cancel{m}a$$
$$+g\sin\theta \qquad +g\sin\theta$$

$$\frac{\mu_k \cancel{g\cos\theta}}{\cancel{g\cos\theta}} = \frac{g\sin\theta - a}{g\cos\theta}$$

$$\boxed{\mu_k = \frac{g\sin\theta - a}{g\cos\theta}}$$

$$\boxed{\mu_s = \tan\theta}$$

PULLY-INCLINE COMBINATION



$$\Sigma F_{x_1} = T - F_f - F_{xg} = m_1 a$$
$$= T - \mu_k m_1 g\cos\theta - mg\sin\theta = m_1 a$$

$$\Sigma F_{y2} = T - m_2 g = -m_2 a$$

$$\frac{T - m_2 g}{-m_2} = \frac{-m_2 a}{-m_2}$$

$$g - \frac{T}{m_2} = a$$

$$T - \mu_k m_1 g \cos\theta - m_1 g \sin\theta = m_1 \left(g - \frac{T}{m_2}\right)$$

$$\cancel{T} - \mu_k m_1 g \cos\theta - m_1 g \sin\theta = \cancel{m_1} g - \frac{m_1 T}{m_2} - T$$

$$-T \qquad -m_1 g \qquad -m_1 g$$

$$+\mu_k m_1 g\cos\theta + m_1 g \sin\theta + m_1 g = +T + \frac{m_1 T}{m_2}$$

$$m_1 g (\mu_k \cos\theta + \sin\theta + 1) = \left(\frac{T m_2 + m_1 T}{m_2}\right) m_2$$

$$\frac{m_1 m_2 g (\mu_k \cos\theta + \sin\theta + 1)}{m_1 + m_2} = \frac{T\cancel{(m_1 + m_2)}}{\cancel{m_1 + m_2}}$$

FROM LAST LECTURE

$$\boxed{\frac{m_1 m_2 g (\mu_k \cos\theta + \sin\theta + 1)}{m_1 + m_2} = T_{RAMP}} \qquad \boxed{T_{PLAIN} = \frac{2 m_1 m_2 g}{m_1 + m_2}}$$

EXAMPLE

AT A MANUFACTURING FACILITY A BOX (138.0 kg) EN ROUT TO AMAZON FOR FULLFILLMENT. A WORKER PULLS A BOX AT AT 20.00° AT 900.0 N. WHAT IS THE μ_k IF THE BOX IS MOVING AT 2.762 m/s²? IF IT IS PUSHED UP A RAMP OF 30.00° WITH THE SAME μ_k, WHAT IS THE ACCELERATION? FINALLY, THE TRUCK WITH T# BOX (14,000 kg) WHAT IS TH ADVANTAGE OF A DIRECT VERSUS 17.00° LIFT WITH A 7,500 kg COUNTER WEIGHT?

$$\mu_k = \frac{F_{pull}\cos\theta - ma}{mg}$$

$$= \frac{(900.0N)(\cos(20.00°)) - (138.0\,kg)(2.762\,m/s^2)}{(138.0\,kg)(9.810\,m/s^2)}$$

$$= 0.343$$

$$\mu_k = \frac{g\sin\theta - a}{g\cos\theta}$$

g cosθ $\cancel{g\cos\theta}$

$$\mu_k g\cos\theta = \cancel{g\sin\theta} - a$$

$$-g\sin\theta \quad -\cancel{g\sin\theta}$$

$$\mu_k g\cos\theta - g\sin\theta = a \Rightarrow g\sin\theta - \mu_k g\cos\theta = a$$

$$(9.810\,m/s^2)\sin(30.00°) - (0.343)(9.810\,m/s^2)\cos(30.00°) = a$$

$\boxed{= 1.991\,m/s^2 = a}$ (UP THE RAMP)

$$T_{PLAIN} = \left(\frac{2m_1m_2}{m_1+m_2}\right)g = \left(\frac{2(14{,}000\,kg)(7{,}500\,kg)}{14{,}000\,kg + 7{,}500\,kg}\right)(9.810\,m/s^2)$$

$$= \boxed{95{,}820\,N}$$

$$T_{RAMP} = \frac{m_1m_2\,g\,(\mu_k\cos\theta + \sin\theta + 1)}{m_1+m_2}$$

$$= (14{,}000\,kg)(7{,}500\,kg)\frac{((0.343)(\cos(17.00°) + \sin(17.00°) + 1))}{(14{,}000\,kg + 7{,}500\,kg)} \times (9.810\,m/s)$$

$= \boxed{77{,}630\,N}$ IT IS EASIER ON THE RAMP