Lecture 19. Energy. Friction. Problems.

Note Title 10/10/2011

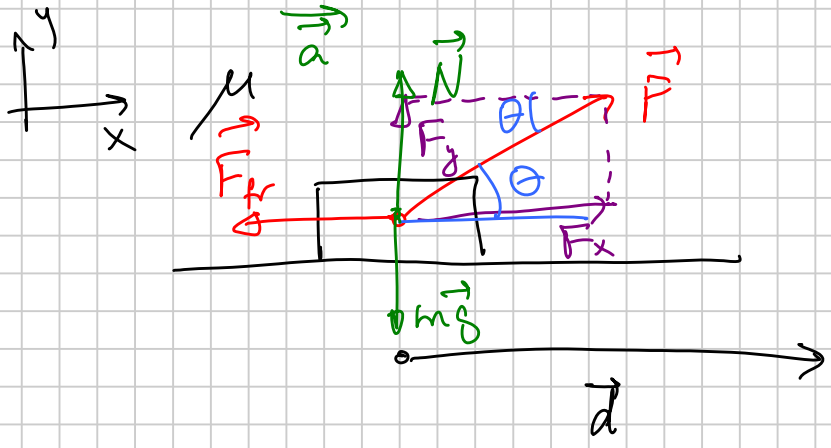
$$PE + KE = const = E_{tot}$$

$$mgh + \frac{1}{2}mv^2 = const$$

$$W_{AB} = KE_B - KE_A$$

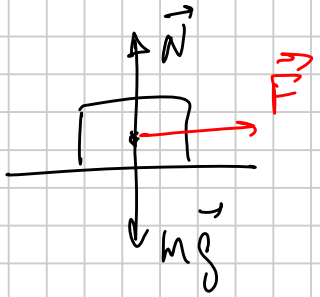
$$W_{AB} = \int_A^B \vec{F} \cdot d\vec{r}$$

if $\vec{F} = const$ $\quad W_{AB} = \vec{F} \cdot \vec{d}_{AB}$



$v - ?$

$v_0 = 0$



$F_{fr} = \mu N$

$y: \quad N_y + F_y - mg = 0 \quad \Rightarrow \quad N = mg - F_y = \underline{mg - F\sin\theta}$

$N_y = N$

$x: \quad F_x - F_{fr} = ma$

$F\cos\theta - \mu N = ma$

$F\cos\theta - \mu(mg - F\sin\theta) = ma$

$W_F = F\cos\theta \cdot d = \frac{1}{2}mv^2 + W_{F_{fr}}$

$W_{F_{fr}} = -F_{fr} \cdot d = -(mg - F\sin\theta)d\mu$

$-mgd\mu + Fd\mu\sin\theta$

$W_F + W_{F_{fr}} = W_{AB} = KE_B - 0$

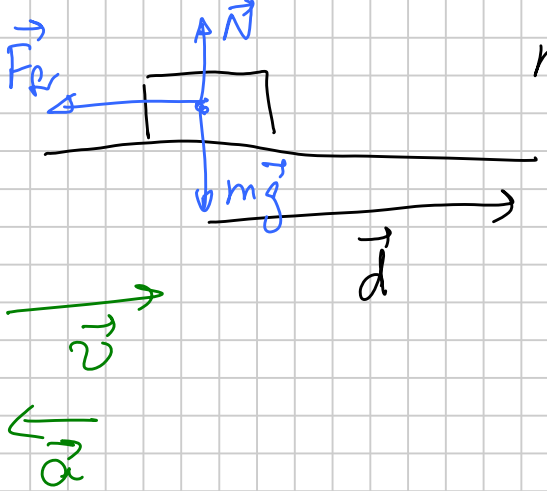
$>0 \quad <0$

$F\cos\theta \cdot d = \frac{1}{2}mv^2 + \mu mgd - Fd\sin\theta\mu$

$\frac{1}{2}mv^2 = F\cos\theta \cdot d - \mu mgd + Fd\mu\sin\theta$

$v^2 = \frac{2Fd\cos\theta}{m} - 2\mu gd + \frac{2Fd\mu\sin\theta}{m}$

EX



m, μ, d $\quad v_0 - ?$ $\quad N = mg$

$$KE_0 = \frac{1}{2} m v_0^2 \qquad KE_f = 0$$

$$W_{AB} = KE_f - KE_0 = -\frac{1}{2} m v_0^2$$

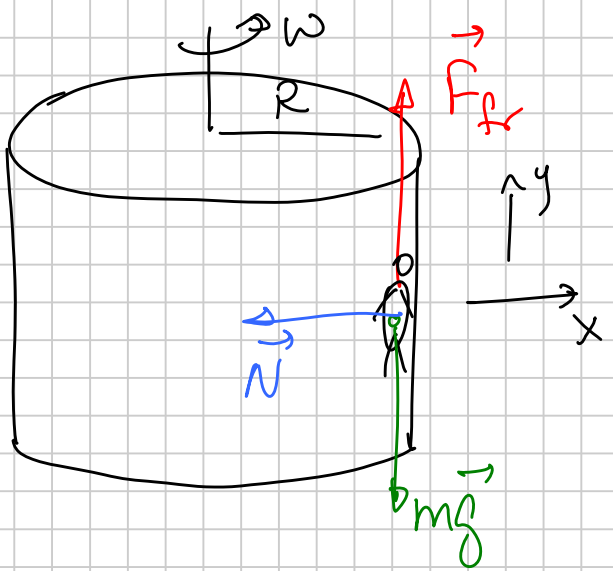
$$W_{Fr} = \vec{F}_{fr} \cdot \vec{d} = -F_{fr} \cdot d = -\mu N \cdot d = -\mu m g d$$

$$-\frac{1}{2} m v_0^2 = -\mu m g d$$

$$v_0^2 = 2 \mu g d$$

$$v_0 = \sqrt{2 \mu g d}$$

$d = 20\,m \quad \mu = 0.1 \quad v_0 = \sqrt{2 \cdot 0.1 \cdot 10 \cdot 20} = \sqrt{40} \approx 6.3\ m/s$



$y: F_{fr} = mg$

$x: N = ma_c$

$F_{fr} = \mu N = mg$

$\mu = 0.4$

$R = 2.1\ m$

$v_{min} - ?$ $\omega - ?$

$v = \omega R$

$\mu m a_c = mg$

$a_c = \frac{v^2}{R}$

$\mu \frac{v^2}{R} = g \Rightarrow v^2 = \frac{Rg}{\mu}$

$v = \sqrt{\frac{Rg}{\mu}} = \sqrt{\frac{2.1 \cdot 10}{0.4}} \approx 7.2\ m/s$

$\omega = \frac{v}{R} = \frac{7.2}{2.1} = 3.43\ \frac{rad}{s}$

$f = \frac{\omega}{2\pi} = 0.55\ \frac{1}{s}$

$T = \frac{1}{f} \approx 2\ s$