Phys 201
Exam 1
Wed 9/29
5:45-6:45 pm
272 Bascom

Applications of Newton's laws

Ex 1 Find the mass

body starts from rest
moves 100m in 5 s
what is mass?

look at $ma_x = F_x$

$m = F/a_x$

find a_x

recall $x - x_0 = v_0 t + \frac{1}{2} a t^2$ ($v_0 = 0$)

so $a_x = 2(x - x_0)/t^2$

$= 2(100\text{m})/(5\text{s})^2$

$= 8\ \text{m/s}^2$

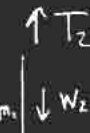
$ma_x = F_x$

$0 = ma_y = F_y = N - mg$

$\Rightarrow N = mg$

So $m = \frac{(40\text{N})}{(8\ \text{m/s}^2)} = 5\text{kg}$

Ex 2 force equilibrium no acceleration



$W_1 = m_1 g$ 3rd law: $T_1' = T_1$

Weight:

$T_1 - W_1 = 0$

$\Rightarrow T_1 = W_1 = m_1 g$

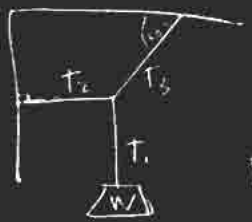
String

$T_2 - W_2 - T_1 = 0$

$T_2 = m_2 g + m_1 g$

Suppose
block weighs 20 N
string weighs 1 N

$T_2 = W_2 + T_1 = 21\ N$



masses = strings

Find T_2

weight

$T_1 + (-W) = 0$

$\Rightarrow T_1 = W$

knot

$\sum F_x = 0 \Rightarrow T_3 \cos 60° - T_2 = 0$

$\sum F_y = 0 \Rightarrow T_3 \sin 60° - T_1 = 0$

cont →

$T_1 = W$

$\Rightarrow T_3 \sin 60^\circ - W = 0$

$\Rightarrow T_3 = \frac{W}{\sin 60^\circ} = 1.155\,W$

$T_2 = T_3 \cos 60^\circ$

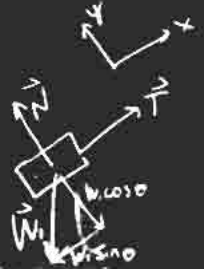
$= (1.155\,W)(\cos 60^\circ) = 0.577W$

SO $T_1 = W$, $T_2 = 0.577W$, $T_3 = 1.155W$

no friction, massless string

given W_1 and θ, what is W_2 so that blocks don't move

$a = 0$ so $T = W_2$



$0 = F_x = T - W_1 \sin\theta$

$0 = F_y = N - W_1 \cos\theta$

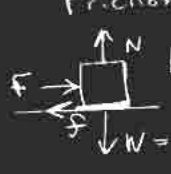
$0 = T - W_1 \sin\theta$

$= W_2 - W_1 \sin\theta$

$$W_2 = W_1 \sin\theta$$

still in force equilibrium

Friction



block at rest

friction force f_s opposes motion

$$f_s \leq (\mu_s N)$$

Coefficient of friction depends on material

block does not move until $F > \mu mg$

If $F > \mu mg$ then friction force becomes:

$$F_k = \mu_k N$$

opposing motion

typically μ_K is a little less than μ

Block on inclined plane with friction

block moves at constant speed

find μ_k

cst speed $\Rightarrow a = 0$

$$\Sigma F_x = \mu_k N - W\sin\theta = 0 \Rightarrow \mu_k N = W\sin\theta$$

$$\Sigma F_y = N - W\cos\theta = 0 \Rightarrow N = W\cos\theta$$

divide:

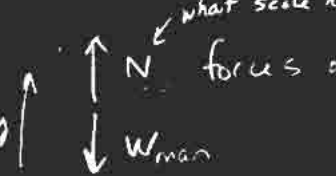
$$\mu_k\left(\frac{N}{N}\right) = \left(\frac{W\sin\theta}{W\cos\theta}\right) = \tan\theta$$

Forces not balanced

160 lb man in elevator

Scale reads 200 lbs

Find magnitude & direction of acceleration



$$\vec{F} = m\vec{a}$$

$$F_y = N - W_{man} = m_{man} a_y$$

$$a_y = \frac{N - W_{man}}{m_{man}} = \frac{N}{(m_{man} g)} - g$$

$$a_y = \frac{(200\ lb)}{(160\ lb)} g - g = \frac{(200 - 160)\ lb}{160\ lb} g = \frac{1}{4} g \quad up.$$