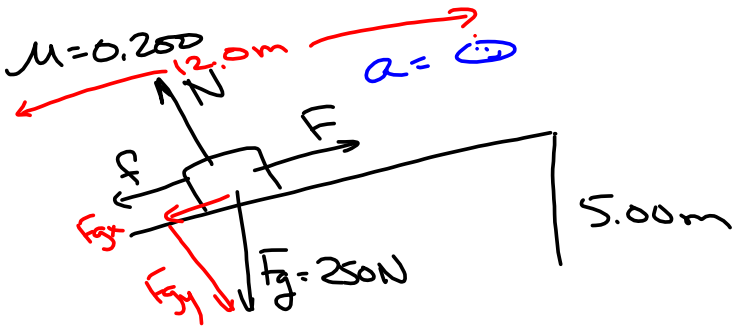
Homework Questions



$f = \mu N$
$= \mu F_{gy}$

$\Sigma F = F - (f + F_{gx}) = \ddot{\smile}$

$F = F_{gx} + f$

$F = 250N \sin\theta + \mu F_g \cos\theta$

$= 250 \times \frac{5}{12} + 0.200 \times 250 \times \frac{11}{12}$

$= 149\,N$

$\sin\theta = \frac{5.00}{12.0}$

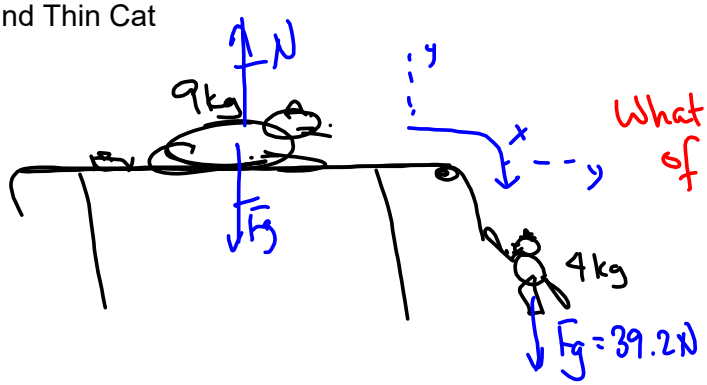
$\cos\theta = \frac{\sqrt{119}}{12}$

$\approx \frac{11}{12}$

Pulleys

Fat Cat and Thin Cat

μ = ☺



What is the acceleration of fat cat?

What does the pulley do? Changes the direction of the force

$\Sigma F = F_g = ma$

both masses are being accelerated by this force

$39.2N = (9+4)a$

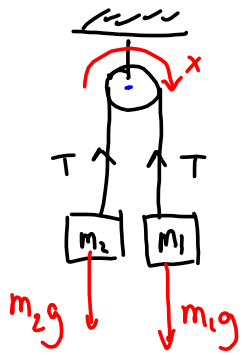
$a = 3.0\ m/s^2$

equivalent questions

FBDs and Tension

Atwood Machine

Assumptions
m_{rope} is small ($\approx$ 😐)
→ m_{pulley} is small
→ axle of pulley is frictionless



Let $m_1 \geq m_2$

$$\Sigma F = m_1 g - m_2 g = (m_1 + m_2) a$$

$$a = \frac{m_1 - m_2}{m_1 + m_2} g \hat{x}$$

Is this equation true if $m_2 > m_1$?
yes!! 😐

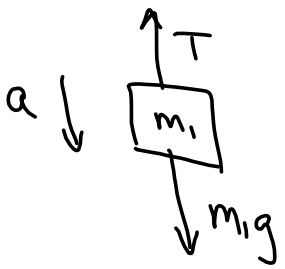
$\frac{m_1 - m_2}{m_1 + m_2}$ = 😐 when $m_1 = m_2$

$\frac{m_1 - m_2}{m_1 + m_2} = 1$ when $m_1 \gg m_2$ or $m_2 = 0$

What is the tension in the rope?

Need a FBD

choose m_1



$$\Sigma F = m_1 g - T = m_1 a$$ ← only m_1

This ΣF is only applied to m_1, not the system

$$T = m_1 (g - a)$$

$$= m_1 \left(g - \frac{m_1 - m_2}{m_1 + m_2} g \right)$$

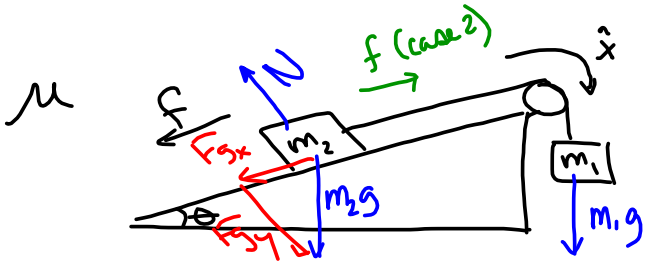
$$= m_1 g \left(1 - \frac{m_1 - m_2}{m_1 + m_2} \right)$$

$$= m_1 g \left(\frac{m_1 + m_2 - m_1 + m_2}{m_1 + m_2} \right)$$

$$T = \frac{2 m_1 m_2}{m_1 + m_2} g$$

Exercise for tonight
Use an FBD with m_2 to get the same T.

Pulleys and Inclines



3 possibilities

1) m_1 goes down
2) m_1 goes up
3) m_1 doesn't move.

Case 1: $m_1 g \geq F_{gx} + f$

$$\Sigma F = m_1 g - (F_{gx} + f) = (m_1 + m_2) a$$

$$m_1 g - (m_2 g \sin\theta + \mu m_2 g \cos\theta) = (m_1 + m_2) a$$

$$a = \frac{m_1 - m_2(\sin\theta + \mu\cos\theta)}{m_1 + m_2} g \, \hat{x}$$

True when $m_1 \geq m_2(\sin\theta + \mu\cos\theta)$

Case 2: $F_{gx} \geq m_1 g + f$

Flip sign of friction term!

$$a = \frac{m_1 - m_2(\sin\theta - \mu\cos\theta)}{m_1 + m_2} g \, \hat{x}$$ (Note: $a \leq$ ☺)

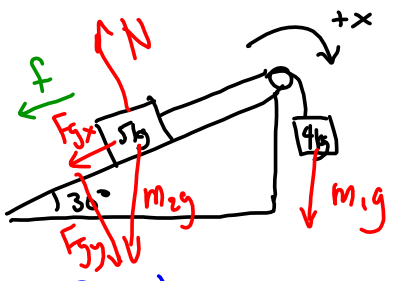
True when $m_1 \leq m_2(\sin\theta - \mu\cos\theta)$

Case 3: $a =$ ☺ $\Sigma F =$ ☺

True when $m_2(\sin\theta - \mu\cos\theta) \leq m_1 \leq m_2(\sin\theta + \mu\cos\theta)$

$$\sin\theta - \mu\cos\theta \leq \frac{m_1}{m_2} \leq \sin\theta + \mu\cos\theta$$

$\mu = 0.30$



Find the acceleration of the system.

1) Compare m_1g, F_{gx} to determine direction of f.

$m_1g = 4kg \cdot g = 39.2N$

$F_{gx} = m_2 g \sin 30° = (5kg) \cdot g \cdot \frac{1}{2} = 24.5N.$

$m_1g > F_{gx}$ so f acts downhill

2) Find the maximum force of friction. Is it greater than $|m_1g - F_{gx}|$?

$f_{max} = \mu N = \mu m_2 g \cos\theta$

$= 0.30 (5kg) \cdot g \cdot \cos 30°$

$= 12.7N$

$m_1g - F_{gx} = 39.2 - 24.5$

$= 14.7N$

Note: If $v \neq 0$, $f = f_{max}$ always (we can have $-\vec{a}$)

If $f_{max} \geq |m_1g - F_{gx}|$, $a = 0$

Otherwise write the ΣF equation.

$\Sigma F = m_1g - (F_{gx} + f) = (m_1 + m_2)a$

$39.2N - (24.5 + 12.7N) = (4+5kg)a$

$\frac{2.0N}{9.0kg} = a$

$a = 0.22 \frac{m}{s^2} \hat{x}$

$\frac{1}{9} = 0.\overline{1}$

$\frac{2}{9} = 0.\overline{2}$

$\frac{1}{11} = 0.\overline{09}$

$\frac{2}{11} = 0.\overline{18}$

$\frac{3}{11} = 0.\overline{27}$

Homework: Questions 6-8, Inclines, 1-2 Pulleys

Problem set #5

What must the coefficient of friction be so that the package just comes to rest at the bottom of the hill.