## Physics 207, Lecture 9, Oct. 4

Agenda:

- Problem Solving and Review for MidTerm I

Assignments:
- For Monday Oct. 9, Read Chapter 7 (Energy and Energy Transfer)
- WebAssign Problem Set 4 due Oct. 18, Tuesday 11:59 PM

Remember
- MidTerm Thurs., Oct. 5, Chapters 1-6, 90 minutes, 7:15-8:45 PM
- NOTE: Assigned Rooms are 105 and 113 Psychology
- McBurney Students: Room 5310 Chamberlin

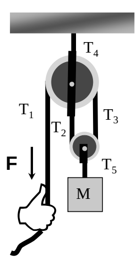


## Problem solving…



## Example with pulley

- A mass M is held in place by a force **F**. Find the tension in each segment of the rope and the magnitude of **F**.
  - ❖ Assume the pulleys are massless and frictionless.
  - ❖ Assume the rope is massless.
- The action of a massless frictionless pulley is to change the direction of a tension.
- Here $F = T_1 = T_2 = T_3$
- Equilibrium means $\Sigma$ **F** = 0 for x, y & z
- For example: y-dir ma = 0 = $T_2 + T_3 - T_5$ and ma = 0 = $T_5 - Mg$
- So $T_5 = Mg = T_2 + T_3 = 2F \rightarrow T = Mg/2$

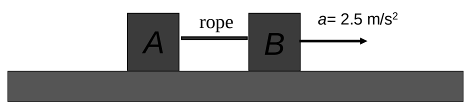





## Lecture 9, *Exercise 1*

- You are going to pull two blocks ($m_A$=4 kg and $m_B$=6 kg) at constant acceleration (a= 2.5 m/s$^2$) on a horizontal frictionless floor, as shown below. The rope connecting the two blocks can stand tension of only 9.0 N. Would the rope break ?

- (A) YES (B) CAN'T TELL (C) NO



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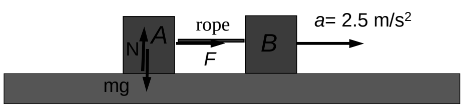
1. FBD for A
2. Newton's 2$^{nd}$ Law x-dir: ma = F = 4 kg x 2.5 m/s$^2$ = 10 N

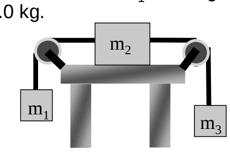
(A) **YES** (B) CAN'T TELL (C) NO






## Example
## Problem 5.40 from Serway

Three blocks are connected on the table as shown. The table has a coefficient of kinetic friction of $\mu_K$=0.40, the masses are $m_1$ = 4.0 kg, $m_2$ = 1.0 kg and $m_3$ = 2.0 kg.

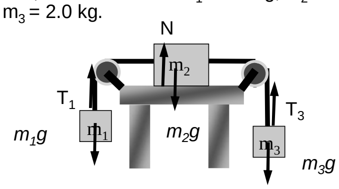



(A) What is the magnitude and direction of acceleration on the three blocks ?

(B) What is the tension on the two cords ?

## Problem 5.40 from the book

Three blocks are connected on the table as shown. The table has a coefficient of kinetic friction of $\mu_K$=0.40, the masses are $m_1$ = 4.0 kg, $m_2$ = 1.0 kg and $m_3$ = 2.0 kg.



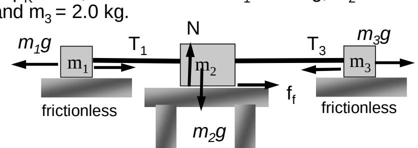

(A) FBD (except for friction)

(B) So what about friction ?



## Problem 5.40 recast as 1D motion

Three blocks are connected on the table as shown. The center table has a coefficient of kinetic friction of $\mu_K$=0.40, the masses are $m_1$ = 4.0 kg, $m_2$ = 1.0 kg and $m_3$ = 2.0 kg.




$m_1g > m_3g$ and $m_1g > (\mu_k m_2g + m_3g)$

and friction opposes motion (starting with $v = 0$)

so $f_f$ is to the right and a is to the left (negative)



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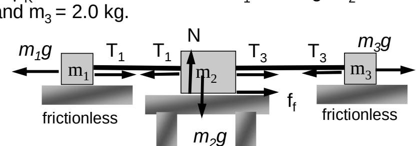



x-dir: 1. $\Sigma F_x = m_2a = \mu_k\, m_2g - T_1 + T_3$

$m_3a = m_3g - T_3$

$m_1a = -m_1g + T_1$

Add all three: $(m_1 + m_2 + m_3)\, a = \mu_k\, m_2g + m_3g - m_1g$



## Forces at different angles

Case1: Downward angled force with friction

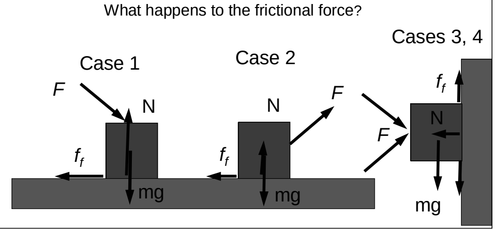
Case 2: Upwards angled force with friction

Cases 3,4: Up against the wall

Questions: Does it slide?

What happens to the normal force?

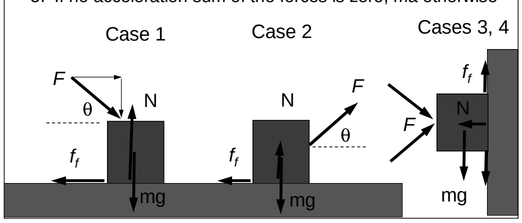
What happens to the frictional force?






## Forces at different angles

1. Identify forces pairs
2. Make a Force Body Diagram
3. Choose directions for x, y and z axes
4. Write down Newton's $2^{nd}$ Law for the x, y and z directions
5. If no acceleration sum of the forces is zero, ma otherwise

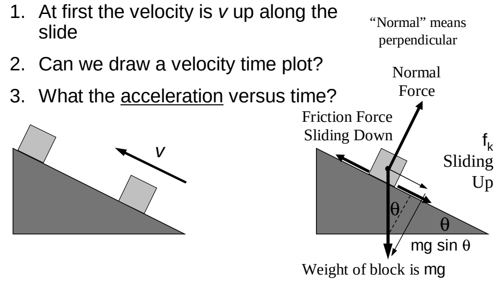





## "Normal" Forces and Frictional Forces

1. At first the velocity is $v$ up along the slide
2. Can we draw a velocity time plot?
3. What the acceleration versus time?

"Normal" means perpendicular




Friction Force = Normal Force × (coefficient of friction)

$F_{friction} = \mu\, F_{normal} = \mu\, mg \sin\theta$