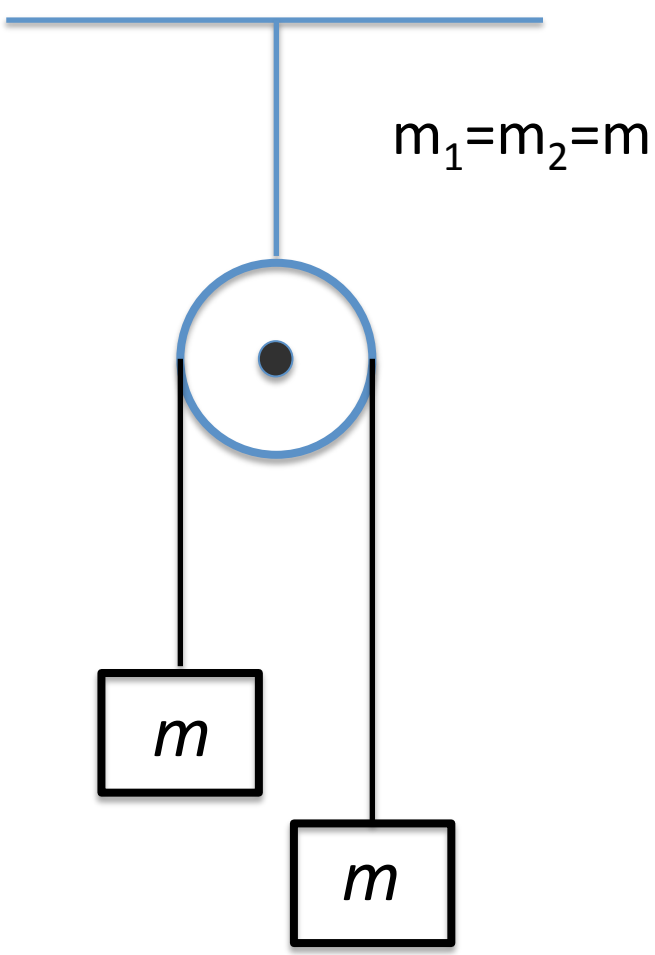
Clicker Question

Room Frequency BA



Two identical blocks with equal masses $m_1 = m_2 = m$ are suspended on a pulley. Initially the block on the left is placed higher than the one on the right and both blocks are at rest. What will happen next:

A) The higher block will move down and the lower block will move up until they are level with each other;

B) The blocks will not move.

C) The higher block will move up and the lower block will move down, so their separation will increase.

Spring 2014

PHYS-2010

Lecture 17

Announcements

- Read Giancoli Chapter 4.
- **CAPA # 6** due next Tuesday at 11 pm.
- **Written homework # 4** due today at 4 pm.
- Two more **Study Sessions** by Prof. Pollock will be held on the next two Tuesdays in G125, 5-6 pm.
- **Midterm II** will be on Thursday, March 6, at 7:30 pm.

The **Atwood machine** was invented in 1784 by Rev. George Atwood as a laboratory experiment to verify the mechanical laws of motion with constant acceleration.

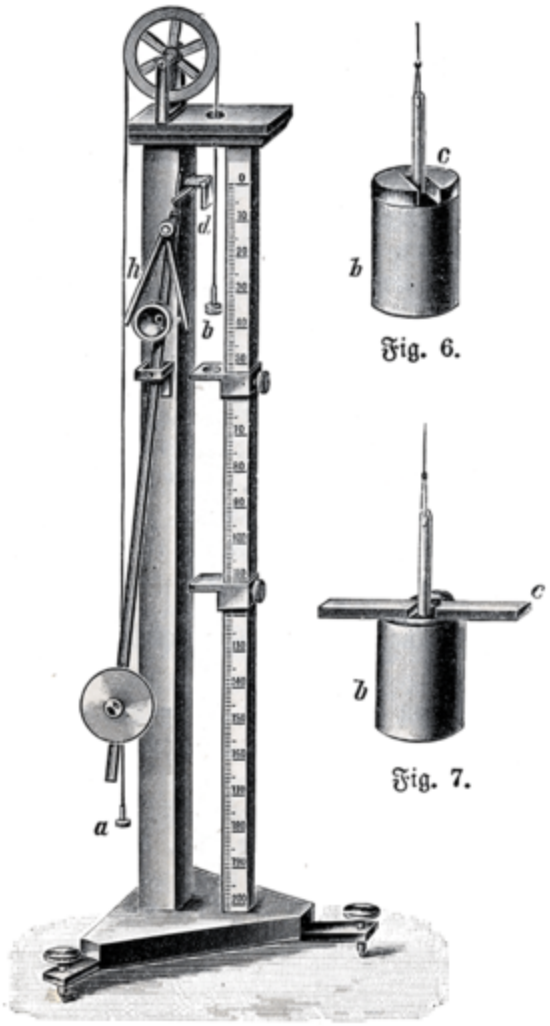
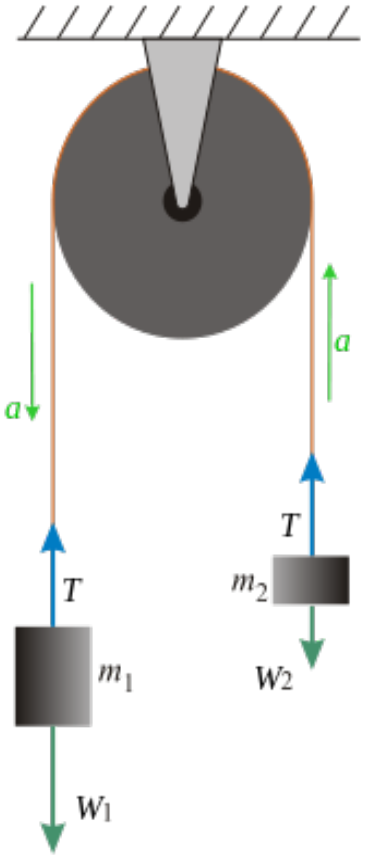
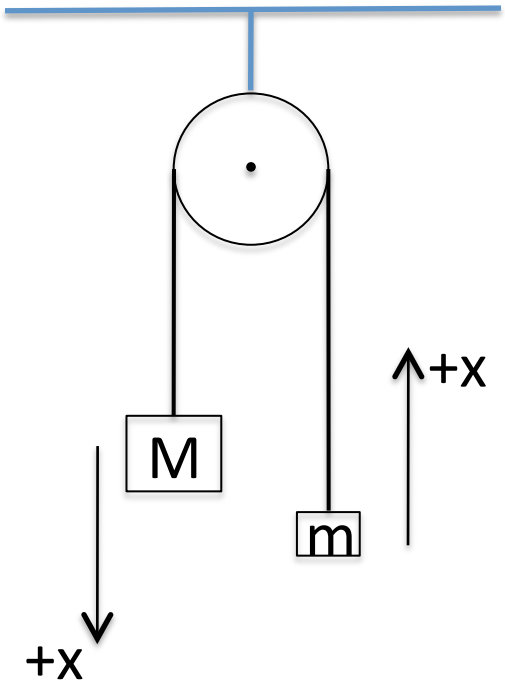


Fig. 5.
Atwoodsche Fallmaschine



http://en.wikipedia.org/wiki/Atwood_machine

Atwood Machine (Pulley)

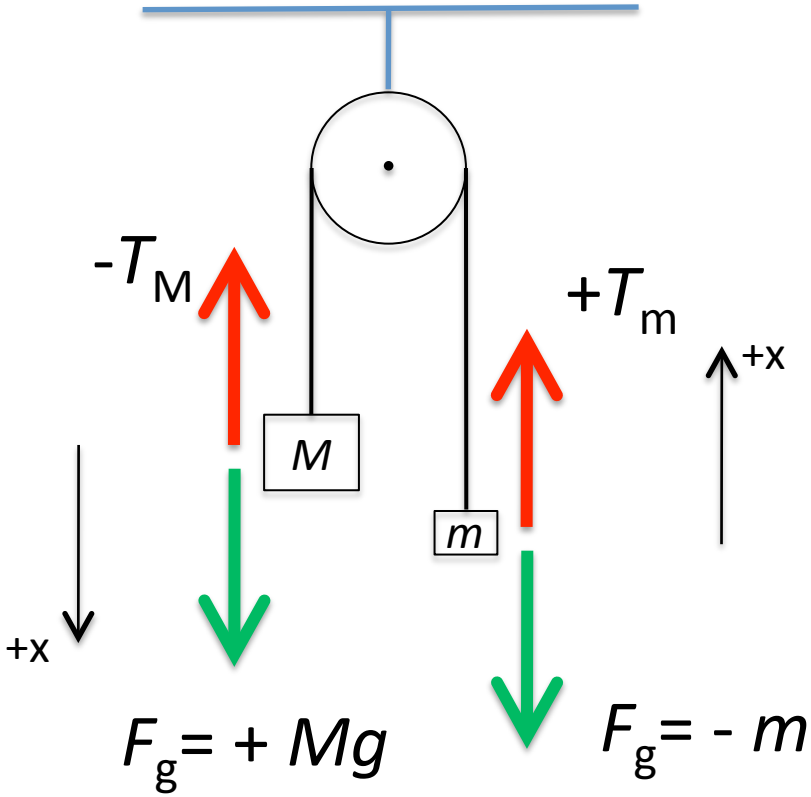


Two objects with masses $M > m$ suspended from a stationary pulley.

Step #1: Choose a coordinate system.

Odd coordinate system (curves around pulley).
This choice means that the acceleration ***a*** for both masses will be the same (**direction + magnitude**).

Step #2: Specify the forces (free-body diagram)



$$Ma_M = Mg - T_M$$

$$ma_m = T_m - mg$$

Accelerations *a* must be same for both objects, otherwise the string would stretch or break.

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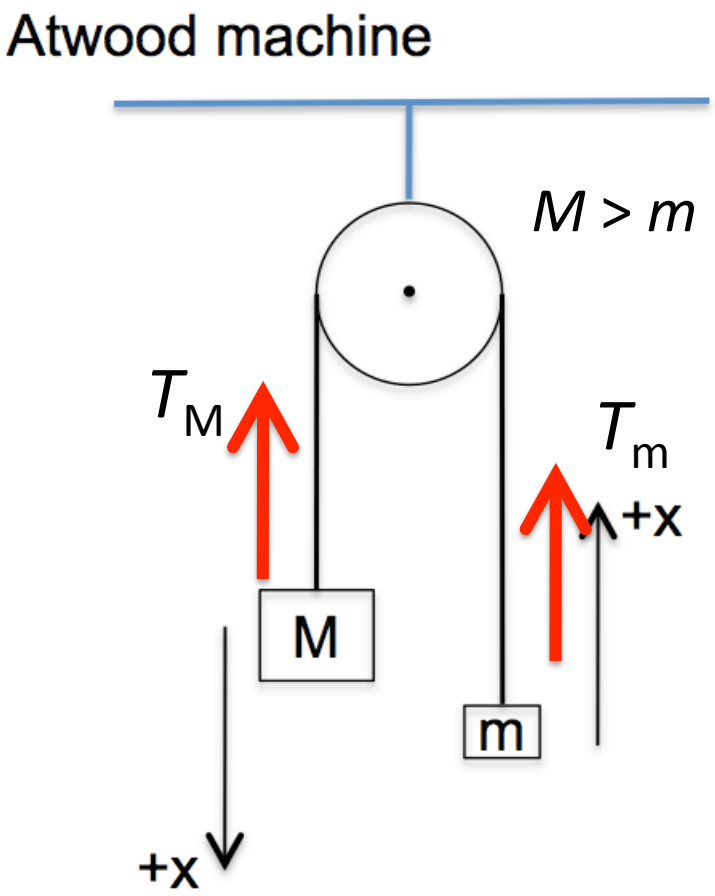


Consider the pair of suspended masses. Assume that the pulley is frictionless and the cord does not stretch.

What is the relationship between the tension T_M in the cord above larger mass M and the tension T_m above the smaller mass?

A) $T_M = T_m$

B) $T_M > T_m$

C) $T_M < T_m$

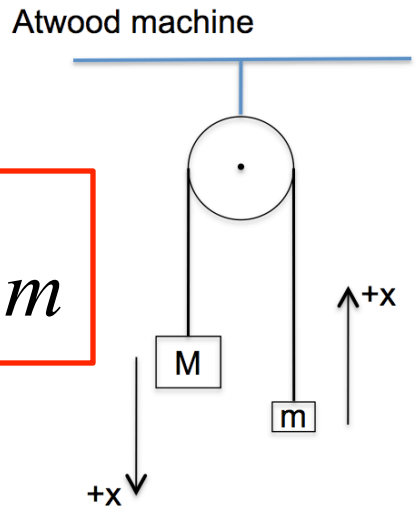
Tension along the cord is constant.

Step #3: Solve the Equations

$$F_M = Ma_M = Mg - T$$

$$F_m = ma_m = T - mg$$

$$a_M = a_m$$



$$T = Mg - Ma$$

$$T = mg + ma$$

Two equations.
Two unknowns (a, T)

$$a = \left[\frac{M - m}{M + m}\right] g$$

Check if the answer makes sense.....

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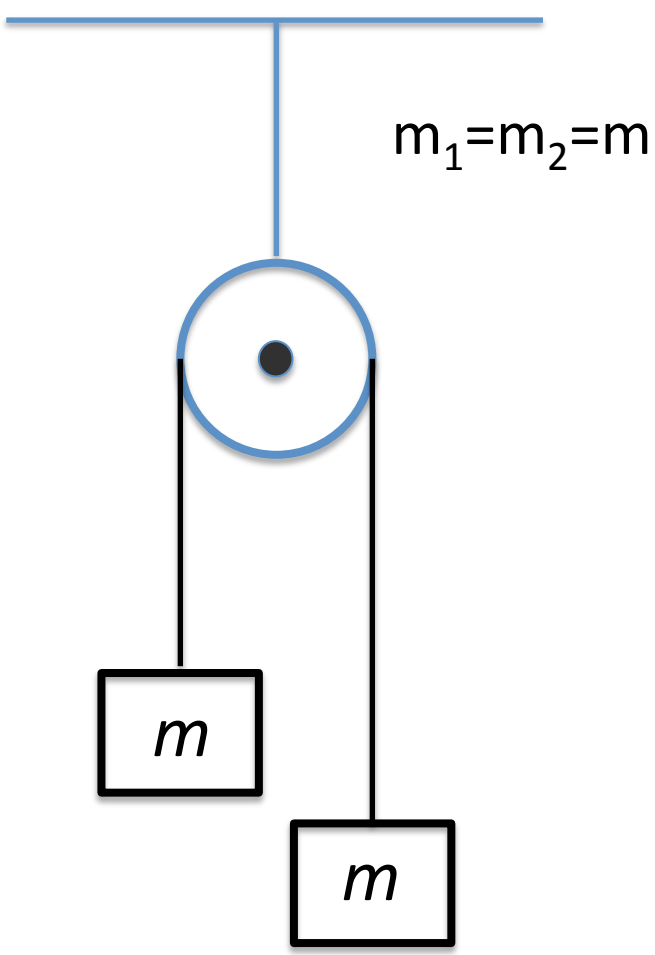

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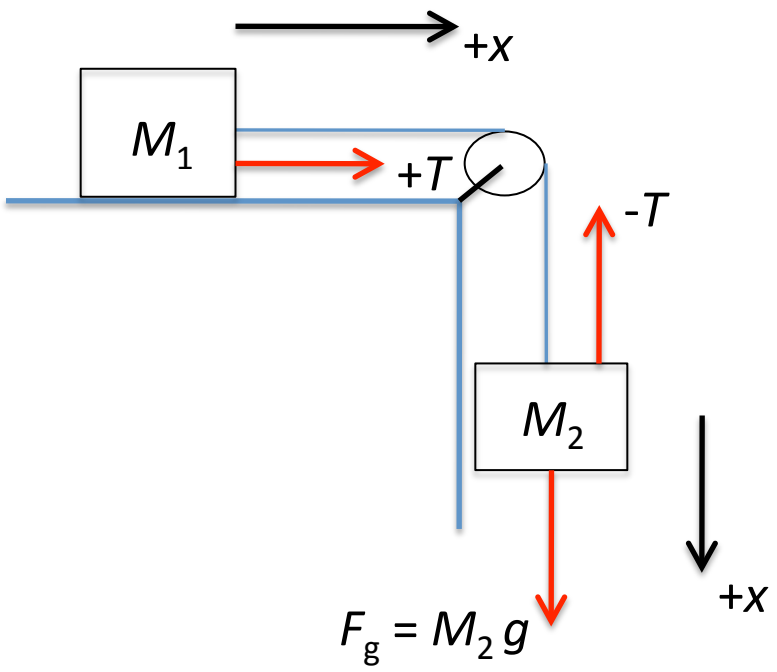


Frictionless table & pulley.

1) Choose coordinates.

2) Identify forces.

3) Write down $F = ma$ for each object.

Mass 1: $M_1 a = T$

Mass 2: $M_2 a = M_2 g - T$

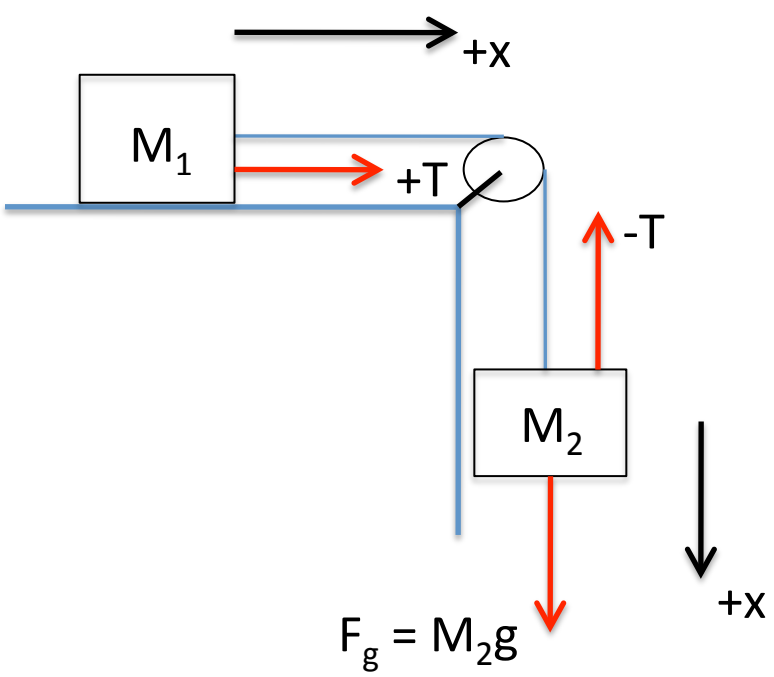
What is $F = ma$ for mass M_2?

(A) $M_2 a = T$

(B) $M_2 a = T - M_2 g$

(C) $M_2 a = M_2 g - T$

(D) $M_2 a = M_2 g$



Frictionless table & pulley.

1) Choose coordinates

2) Identify forces.

3) Write down $F = ma$ for each object

Mass 1: $M_1 a = T$

Mass 2: $M_2 a = M_2 g - T$

Substitute for T in the lower equation

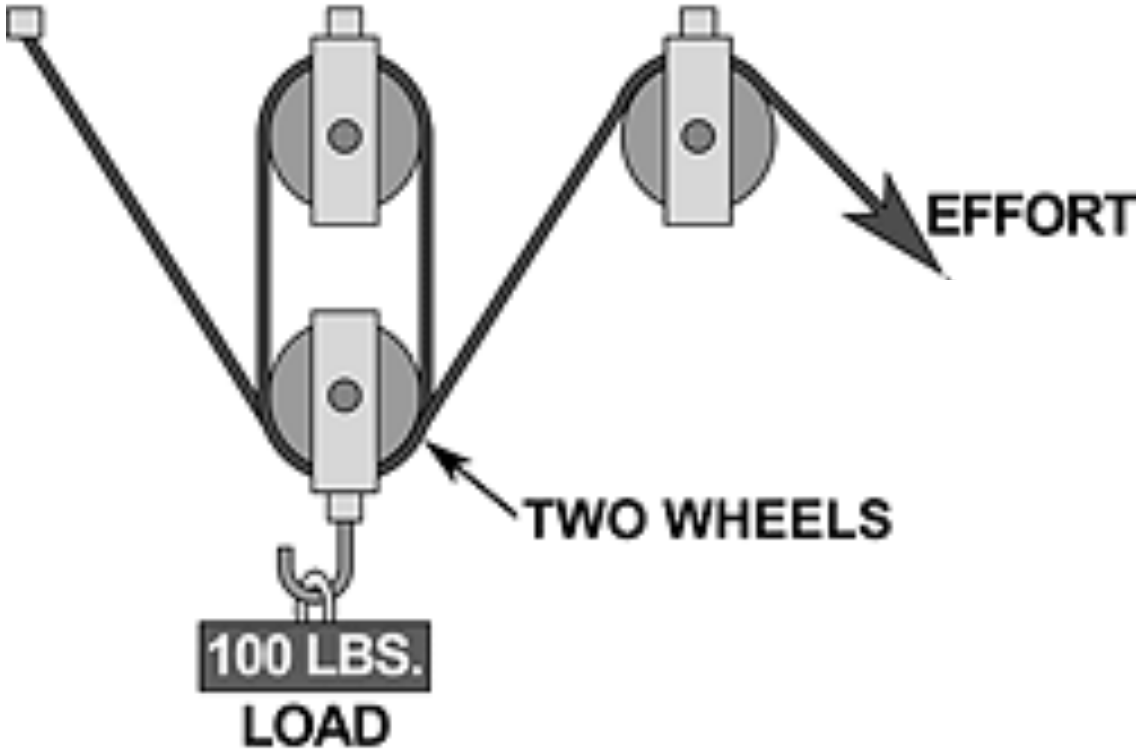
$$M_2 a = M_2 g - M_1 a$$

Solve for a

$$a = \left(\frac{M_2}{M_1 + M_2} \right) g$$

Pulley Advantage

In a system with multiple pulleys (for which there are various possible arrangements), we loop a single continuous rope.



There is only one tension in the rope throughout its length.

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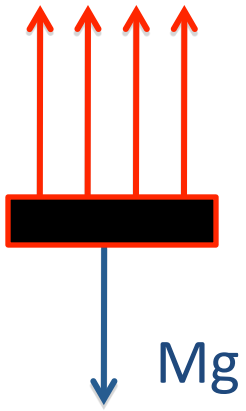
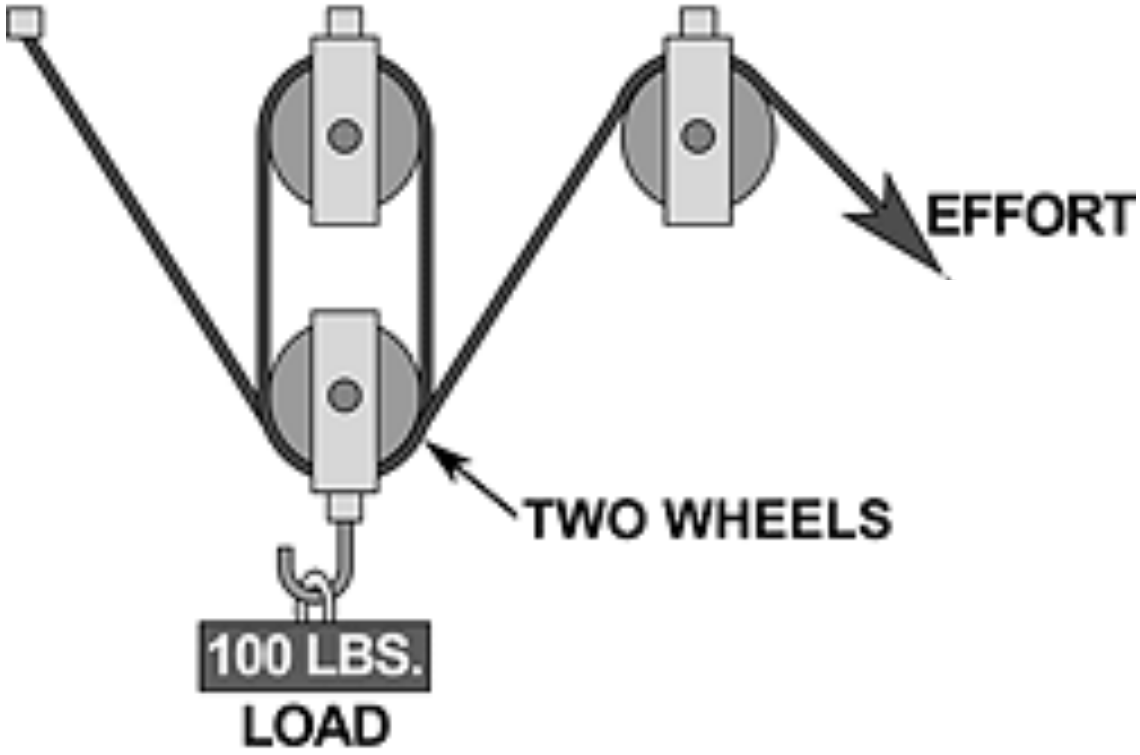
4 Ropes with Tension T pulling up





What is the force (EFFORT) requires to prevent the LOAD from falling?

A) 0 lbs.

B) 25 lbs.

C) 50 lbs.

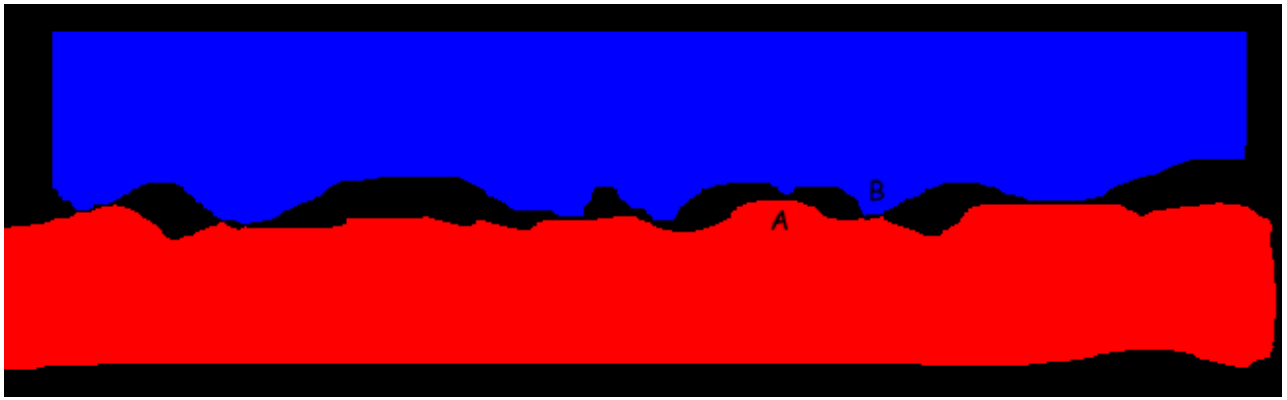
D) 100 lbs.

E) 400 lbs.

Hint: Draw a free-body diagram.

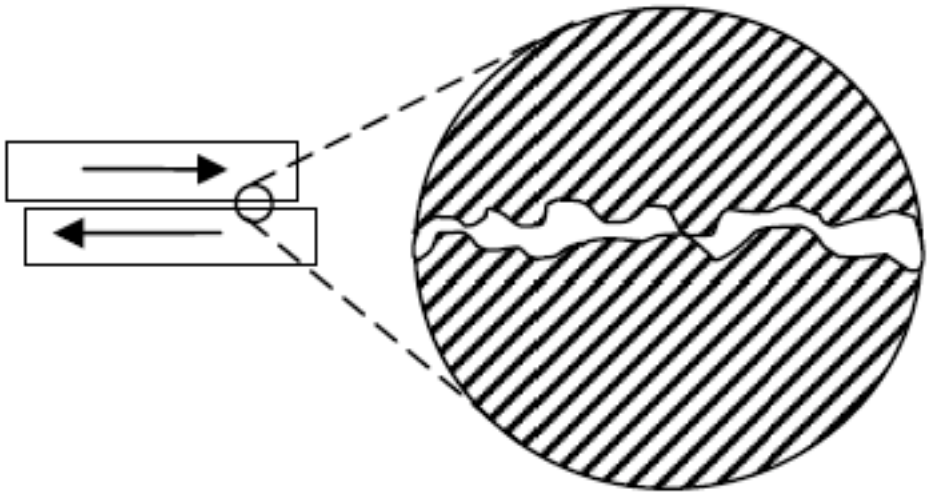
Friction

Why have you been ignoring me all this time?



Very useful – imagine walking without it!

Friction



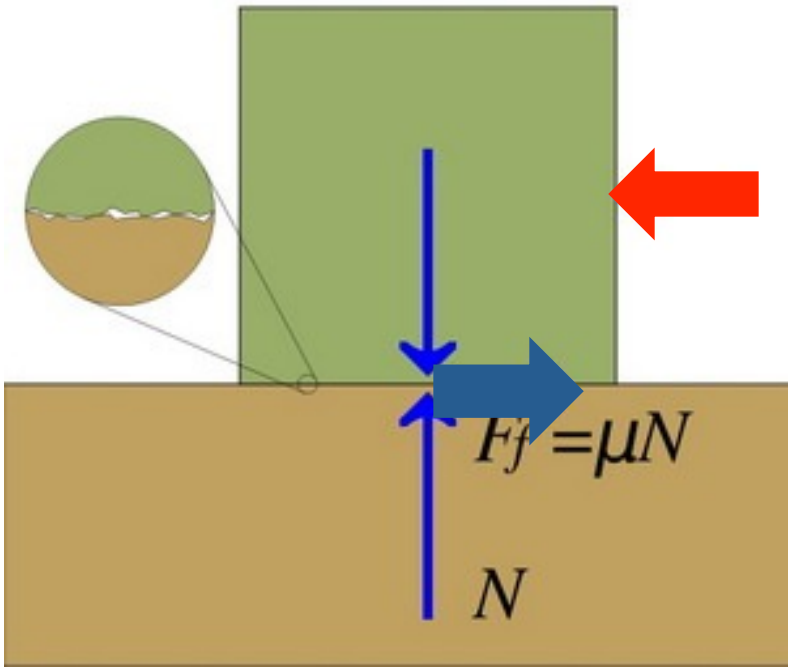
- Caused by microscopic surface roughness.

Friction Force is the contact force resisting the movement of two objects in physical contact past each other along the surface of contact.

Force of Friction depends on:

1. **Characteristics of materials**
2. **Normal force pushing the materials together**

Coefficient of Friction (μ)



When we try to push this green block sideways…

The Force of Friction acts in the opposite direction to resist this pushing force.

•Empirical observation: Magnitude of the force of friction *f* between two surfaces is proportional to the normal force – ***not the area of contact!***

Maximum Force of Friction =

coefficient of friction (μ) x

Normal Force pushing objects together

$$F_f(\max) = \mu N$$