

Tension, Continuous Systems and Differential Equations

8.01

W03D1

Today's Readings:

[Chapter 8 Applications of Newton's Second Law](#),

Sections 8.4: Examples 8.3-4. Section 8.4.2, Section 8.5

Announcements

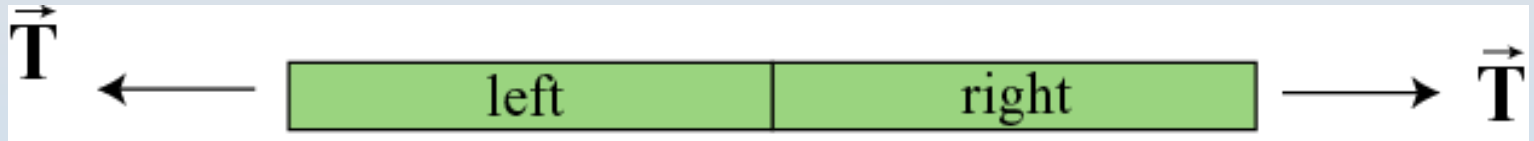
Exam 1: Thursday Sept 19 7:30 pm - 9:30 pm. See Announcements webpage for room assignments

Conflict Exam 1: Friday Sept 20 8-10 am, 10-12 noon. See Announcements webpage for room assignments
You must email padour@mit.edu your reason for requesting to take the conflict exam. The only acceptable conflict is if you have an official MIT class scheduled during the exam time.

Problem Set 2 (Exam 1 Review Problems) Due Week 03 Tuesday at 9 pm in section boxes outside 26-152

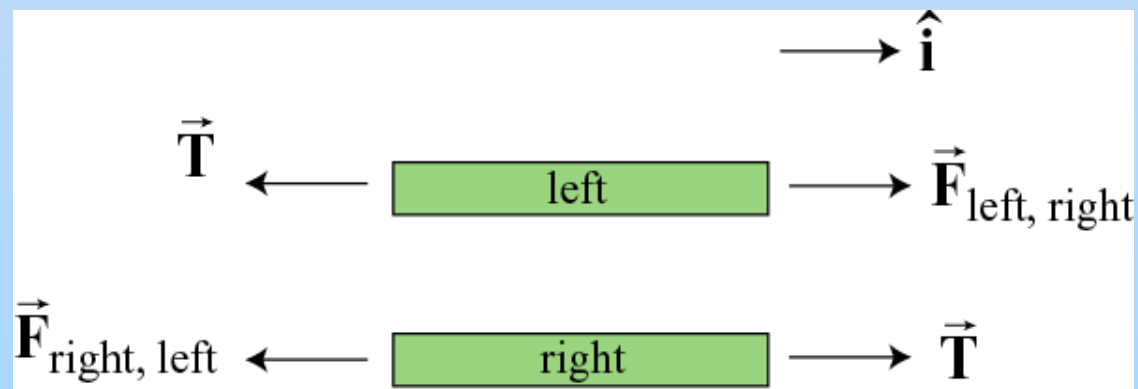
Math Review Week 03 Tuesday at 9 pm in 26-152

Tension in a Rope



The *tension* in a rope at a distance x from one end of the rope is the magnitude of the action-reaction pair of forces acting at that point ,

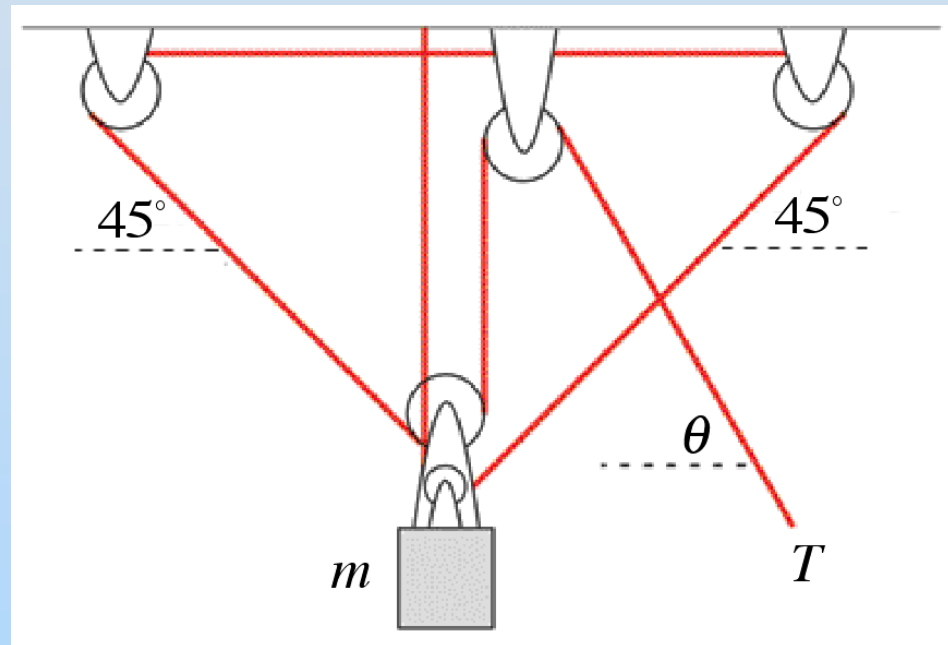
$$T(x) = \left| \vec{F}_{\text{left, right}}(x) \right| = \left| \vec{F}_{\text{right, left}}(x) \right|$$



Concept Q.: Constraints and Pulleys

A massless rope is attached to the ceiling at one end and held stationary with tension T at the other end. Through a system of frictionless pulleys it supports a body of mass m . What is the value of m ?

1. $4T / g$
2. $4T \sin \theta / g$
3. $(2 + \sqrt{2})T / g$
4. $(2 + \sqrt{2})T \sin \theta / g$
5. $5T / g$



Why you need to know physics



Table Problem: Painter on Platform

A painter pulls on each rope with a constant force F . The painter has mass m_1 and the platform has mass m_2 .

- Draw free body force diagrams for the platform and painter.
- Find the acceleration of the platform.

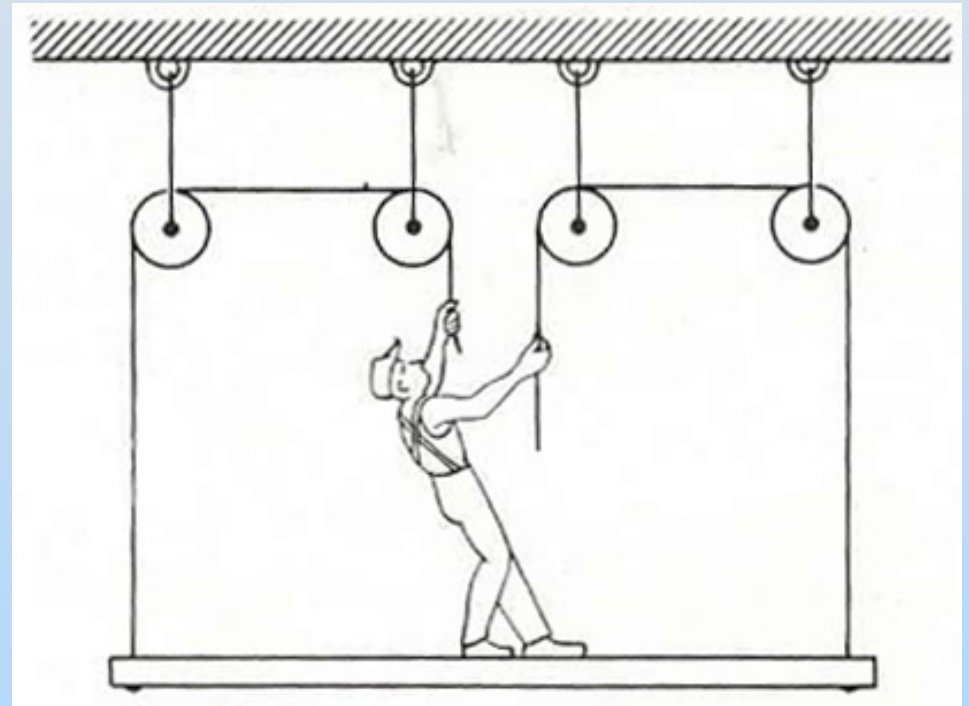


Table Problem: Tension in a Rope

Suppose a rope of mass m hangs between two trees. The ends of the rope are at the same height and they make an angle θ with the trees.

a) What is the tension at the ends of the rope where it is connected to the trees?

b) What is the tension in the rope at a point midway between the trees?

Be sure you show any free body force diagrams or sketches that you plan to use.

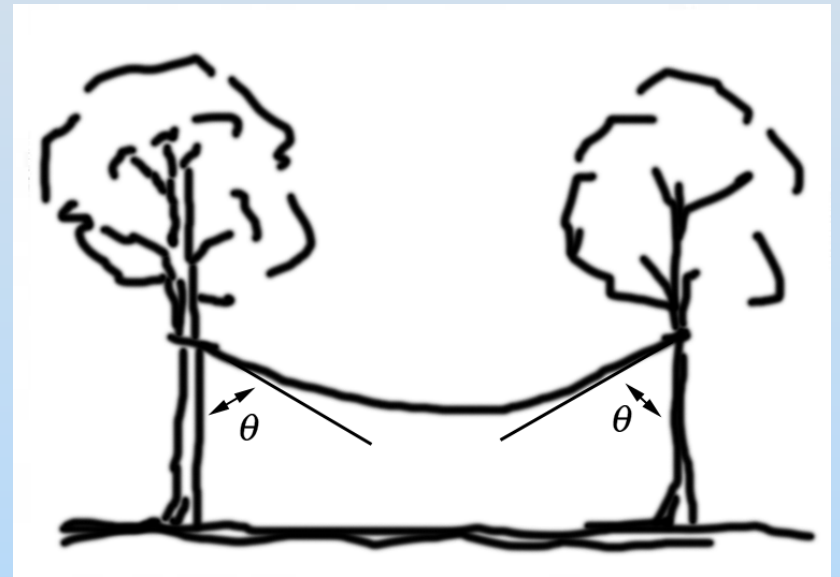
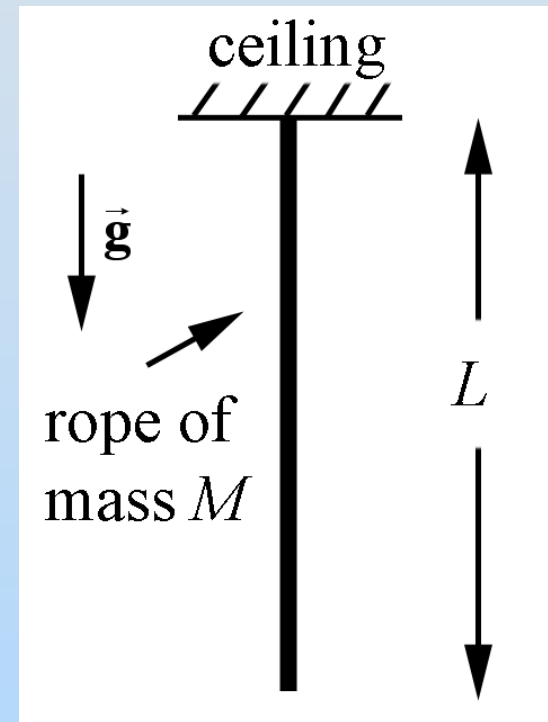


Table Problem: Tension in a Suspended Rope

Suppose a uniform rope of mass M and length L is suspended from a ceiling. The magnitude of the acceleration due to gravity is g .

- a) Find the tension in the rope at the upper end where the rope is fixed to the ceiling.
- b) Find the tension in the rope as a function of the distance from the ceiling.
- c) Find an equation for the rate of change of the tension with respect to distance from the ceiling in terms of M , L , and g .



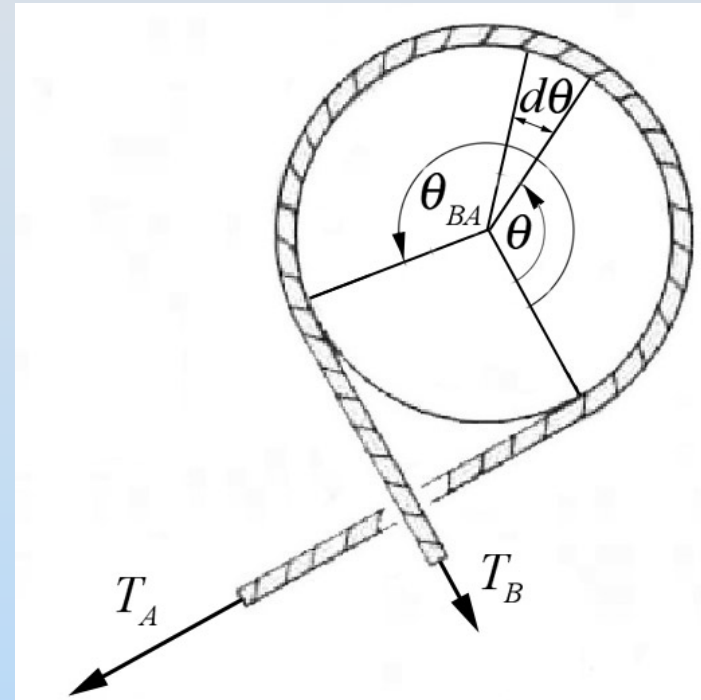
Mini-Experiment: Wrapping Friction

Worked Example: Capstan

In the capstan, show that when the rope is just slipping and the load on the rope pulls it with a force T_A , then the sailor holds it with a much smaller force T_B given by

$$T_B = T_A e^{-\mu_s \theta_{BA}}$$

where μ_s is the coefficient of static friction and θ_{BA} is the total angle subtended by the rope on the drum.

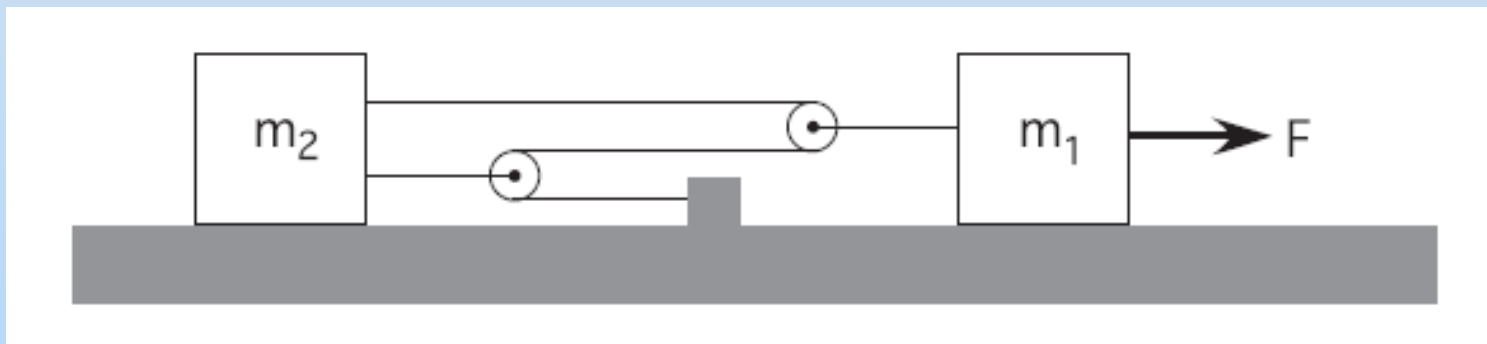


Review

Friday Group Problems

Group Problem: Blocks and Pulleys on Table

Two blocks rest on a frictionless horizontal surface. They are connected by 3 massless strings and 2 frictionless, massless pulleys as shown above. A force F is applied to block 1. What is the resulting acceleration of block 1?



Things to do for W03D2

Prepare for Exam 1: 7:30-9:30 pm

See Announcements webpage for room assignments

Topics:

Vectors

1 & 2 Dimensional Kinematics

Force and Newton's Second Law

Reading Assignment: W04D1

Chapter 6 Circular Motion,

Sections 6.1-6.2