Statics - TAM 210 & TAM 211

Lecture 5

January 26, 2018

Announcements

- MATLAB training sessions
  - ~~Wed 24, Thu 25,~~ Fri 26, and Mon 29
  - DCL **L440**, Tutorial: 6:30-7:30 pm, Q&A: 7:30-8:00 pm
- Discussion section team formation using CATME. Sign up by Sunday night. Look for email from Matt Milner with info.

- Upcoming deadlines:

- Friday (1/26)
  - Mastering Engineering Tutorial3
- Tuesday (1/30)
  - Prairie Learn HW2
- Quiz 1 (1/31-2/2)
  - Reserve testing time at CBTF
  - https://cbtf.engr.illinois.edu/sched/
  - DO NOT MISS TEST TIME.
  - NO MAKE-UP.

Recap of Lecture 4

- Position vectors
- Force vector directed along a line
- Dot (scalar) product
- Cross (vector) product

Chapter 3: Equilibrium of a particle

Goals and Objectives

- Practice following general procedure for analysis.
- Introduce the concept of a free-body diagram for an object modeled as a particle.
- Solve particle equilibrium problems using the equations of equilibrium.

General procedure for analysis

1. Read the problem carefully; write it down carefully.
2. MODEL THE PROBLEM: Draw given diagrams neatly and construct additional figures as necessary.
3. Apply principles needed.
4. Solve problem symbolically. Make sure equations are dimensionally homogeneous
5. Substitute numbers. Provide proper units *throughout*. Check significant figures. Box the final answer(s).
6. See if answer is reasonable.

Most effective way to learn engineering mechanics is to *solve problems!*

Equilibrium of a particle

According to Newton's first law of motion , a particle will be in **equilibrium** (that is, it will remain at rest or continue to move with constant velocity) if and only if

where $\vec{F}$ is the resultant force vector of all forces acting on a particle.

3-Dimensional forces: equilibrium requires

Equilibrium of a particle (cont)

Coplanar forces: if all forces are acting in a single plane, such as the "xy" plane, then the equilibrium condition becomes

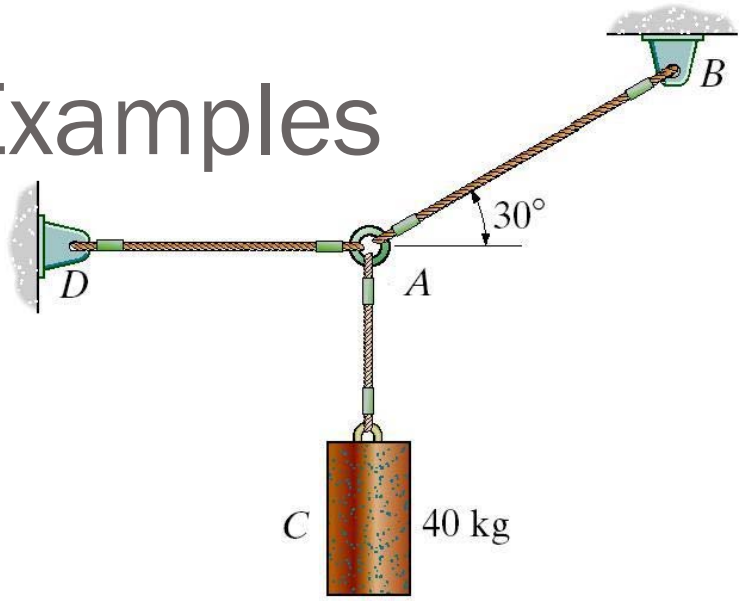
Free body diagram

Drawing of a body, or part of a body, on which all forces acting on the body are shown.

- Key to writing the equations of equilibrium.
- Can draw for any object/subsystem of system. Pick the most appropriate object. (Equal & opposite forces on interacting bodies.)

- ❑ Draw Outlined Shape: image object free of its surroundings
  - ❑ Sometimes may collapse large object into point mass
- ❑ Establish x, y, z axes in any suitable orientation
  - ❑ Show positive directions for translation and rotation
- ❑ Show all forces acting on the object at points of application
- ❑ Label all known and unknown forces
- ❑ Sense ("direction") of unknown force can be assumed. If solution is negative, then the sense is reverse of that shown on FBD

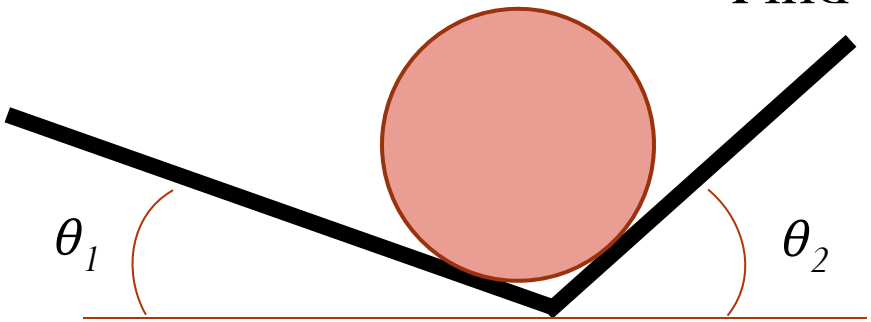
Examples



Find the tension in the cables for a given mass.

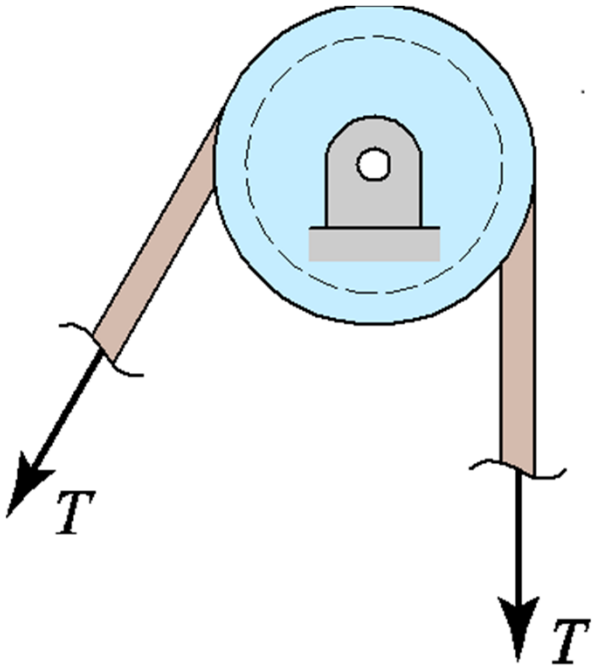
Find the forces in cables AB and AC?

Find contact forces on smooth surface



Idealizations

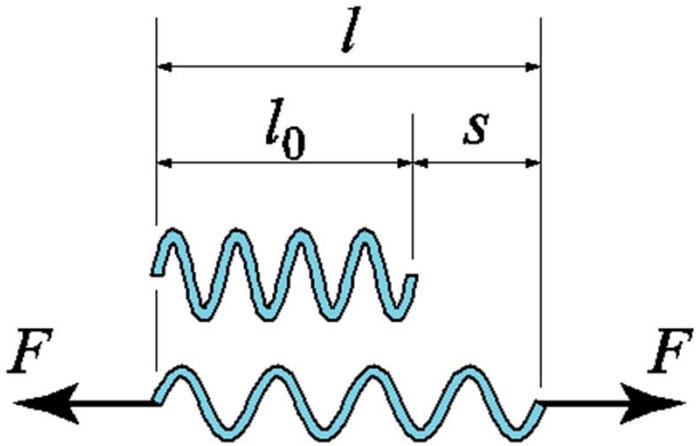
Pulleys are (usually) regarded as frictionless; then the tension in a rope or cord around the pulley is the same on either side.



Frictionless pulley

Idealizations

Springs are (usually) regarded as linearly elastic; then the tension is proportional to the *change* in length s.



$$F = ks = k(l - l_0)$$

Linearly elastic spring