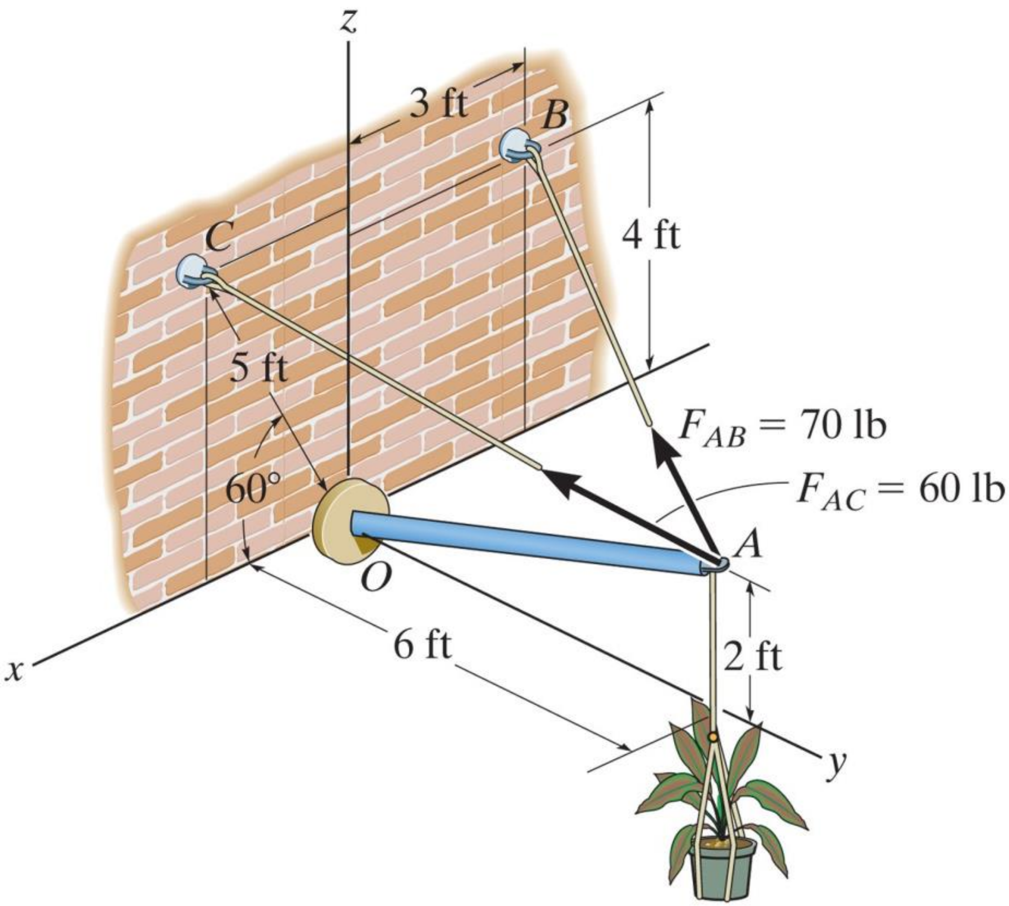
To do ...

- **Quiz 1** sign up now!
  - Tues – Fri of next week (Sept 12 – 15)
  - “Practice” quiz available

- HW4 due **Tues**
- HW 5 due **Thurs**



Determine the projected component of the force vector F_{AC} along the axis of strut AO. Express your result as a Cartesian vector

Chapter 3: Equilibrium of a particle
Main goals and learning objectives

- Introduce the concept of a free-body diagram for an object modelled 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.

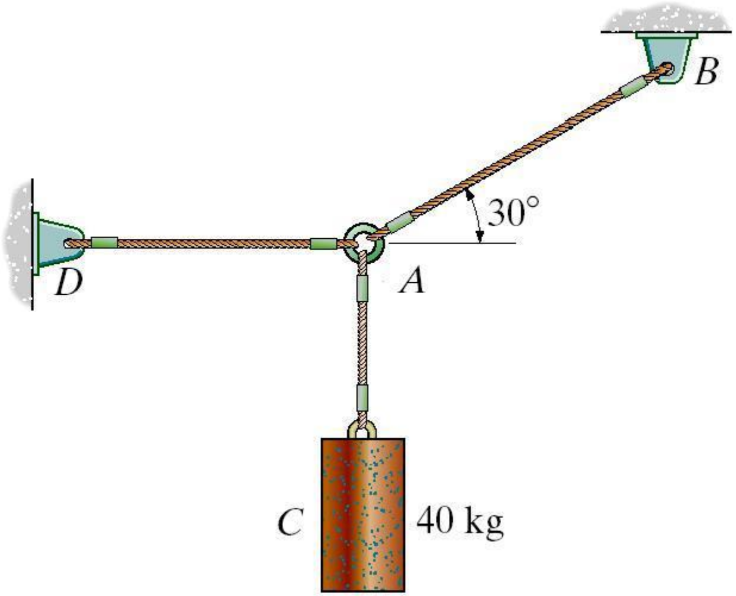
Equilibrium of a particle

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

$$\sum \vec{F} = 0$$

where $\sum \boldsymbol{F} = \boldsymbol{0}$ is the resultant force vector of all forces acting on a particle.

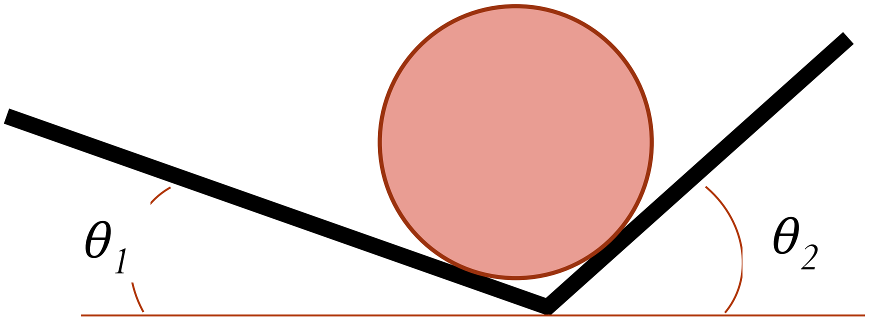
In three dimensions, equilibrium requires:



Find the tension in the cables
For a given mass.

Free body diagram

Idealization

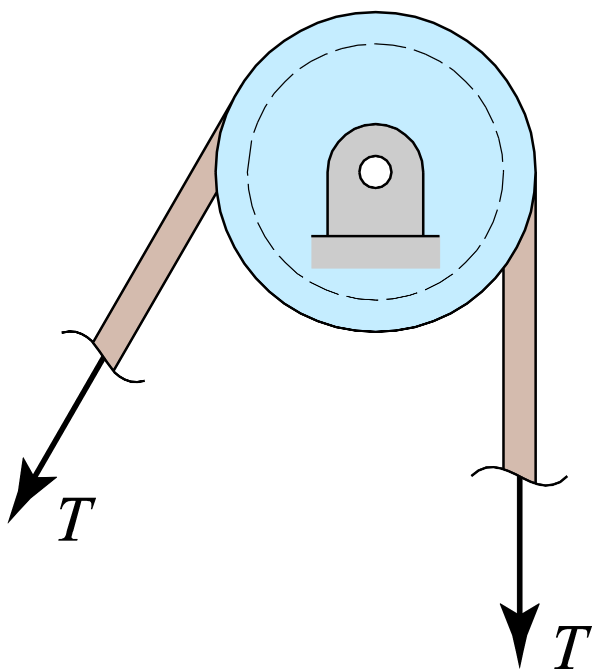


Contact force in smooth surface:

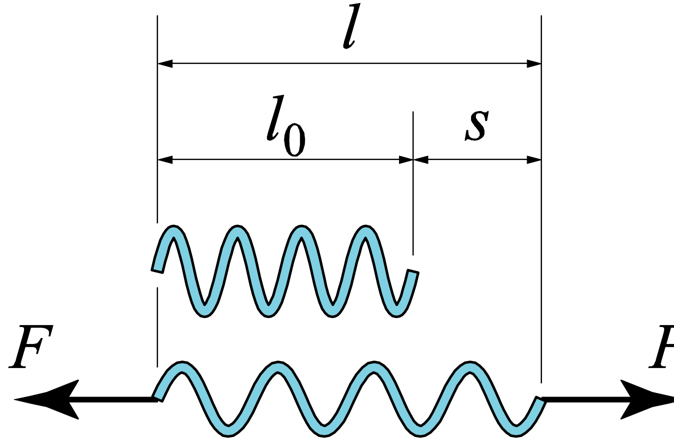
Idealizations

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

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



Frictionless pulley



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

Linearly elastic spring

Equilibrium of a system of particles

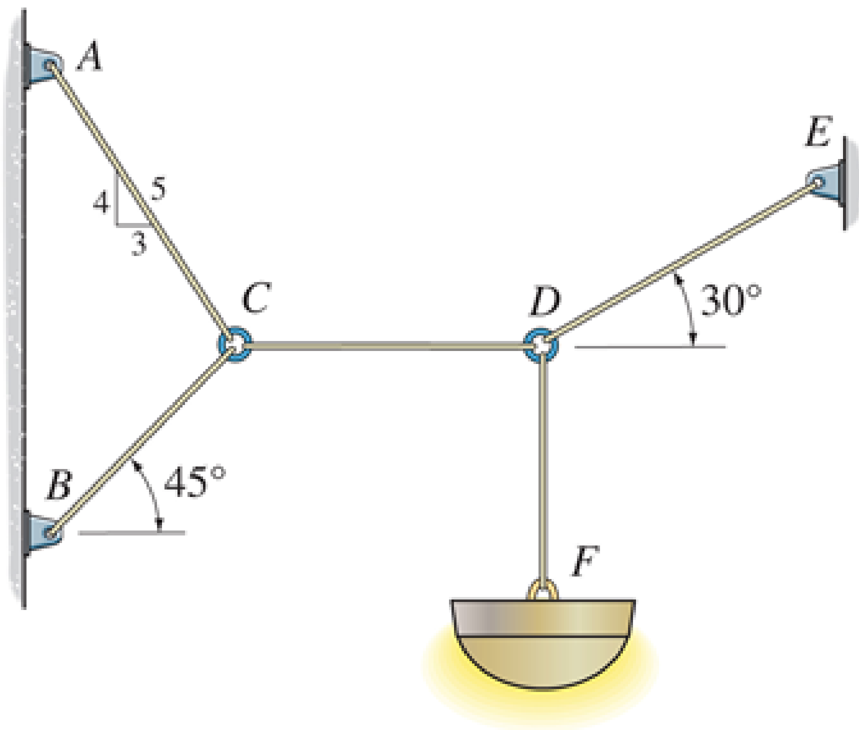
Some practical engineering problems involve the statics of interacting or interconnected particles. To solve them, we use Newton's first law

$$\Sigma \mathbf{F} = \mathbf{0}$$

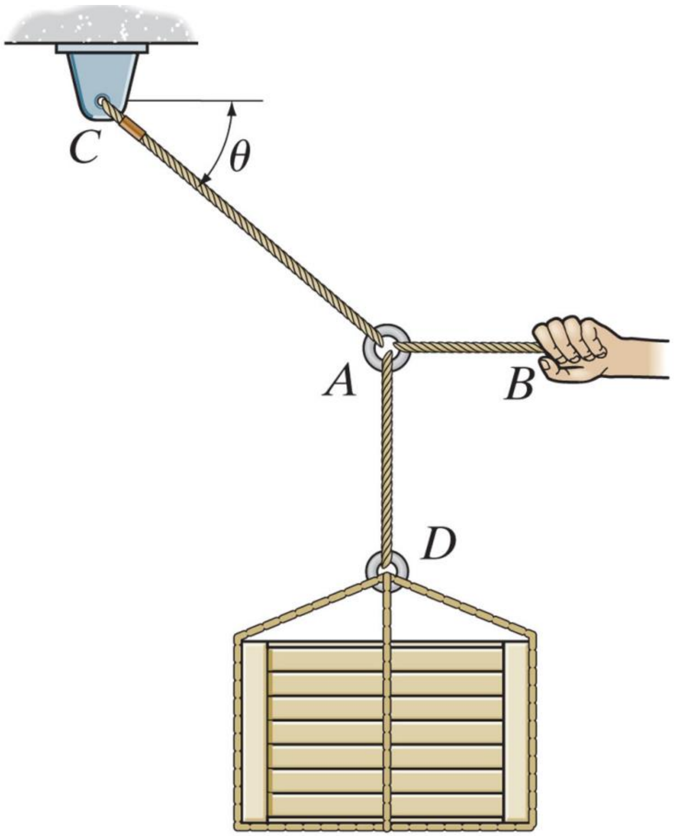
on selected multiple free-body diagrams of particles or groups of particles.

Applications

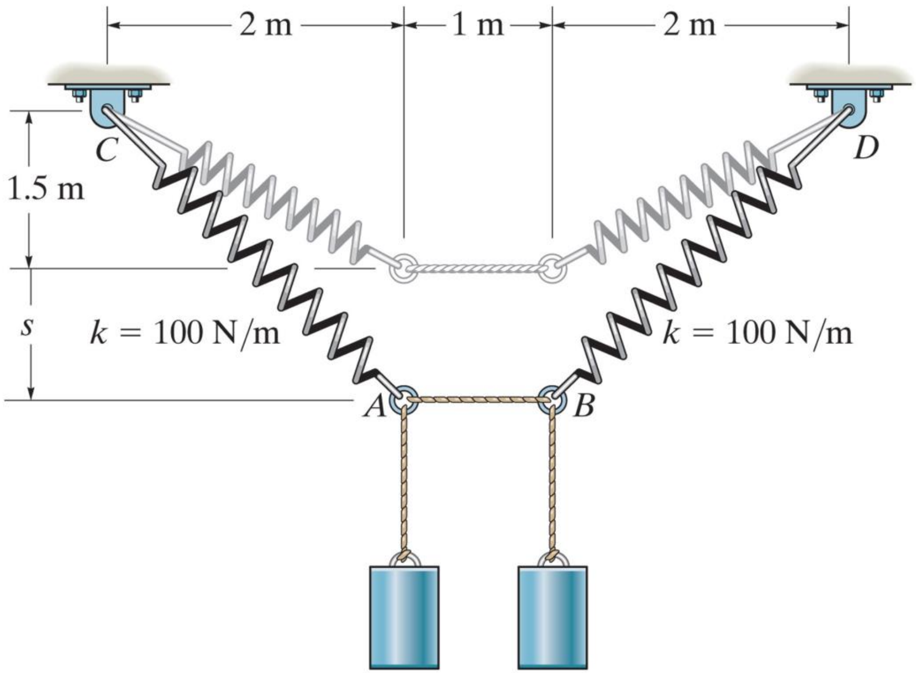
For a spool of given weight, how would you find the forces in cables AB and AC? If designing a spreader bar (BC) like this one, you need to know the forces to make sure the rigging (A) doesn't fail.



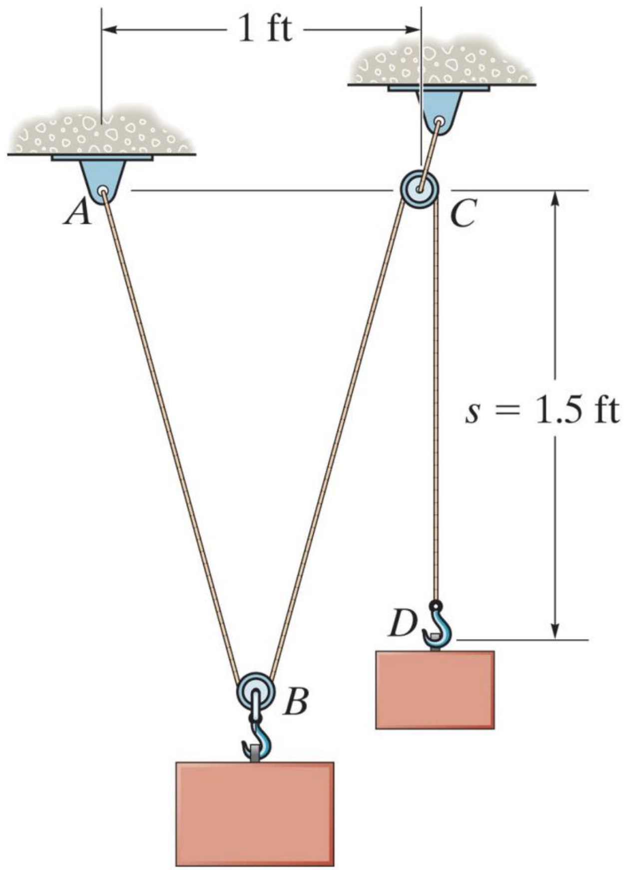
Determine the maximum mass of the lamp that the cord system can support so that no single cord develops a tension exceeding 400N.



If the box has weight 1962 N, determine the force that has to be applied at B to make the system in equilibrium in the configuration below, where $\theta = 40^0$



Determine the mass of each of the two identical cylinders if they cause a sag of s = 0.5 m when suspended from the rings at A and B. Note that s is zero when the cylinders are removed.



A “scale” is constructed with a 4-ft-long cord and the 10-lb block D. The cord is fixed to a pin at A and passes over two *small* frictionless pulleys. Determine the weight of the suspended block B if the system is in equilibrium when $s = 1.5$ft.