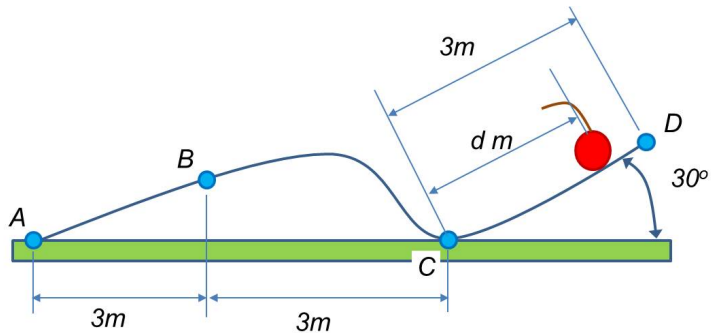


Unless otherwise mentioned, these problems should be solvable using a basic calculator. Practice clear communication by showing all work (free body diagrams, algebra, etc). This will be required to receive full credit on any graded problems.

- The engineers constructing the famous cherry and spoon sculpture in Minneapolis were required to carry out a structural analysis in case of an earthquake. They conducted the analysis by assuming that after an earthquake the foundation was not able to provide any rigid support to the structure. This means that the structure is just resting on the ground. A picture and diagram for the situation is shown below. Assume that:
  - The mass of section ABC is 100 kg and the weight acts at point B.
  - The mass of section CD is 80 kg and the weight acts at the mid-point of CD.
  - The mass of the cherry is 100 kg and the cherry is placed at a distance  $d$  from the point C.
  - Point C acts as a hinge while A acts as roller support.

Complete the following analyses:

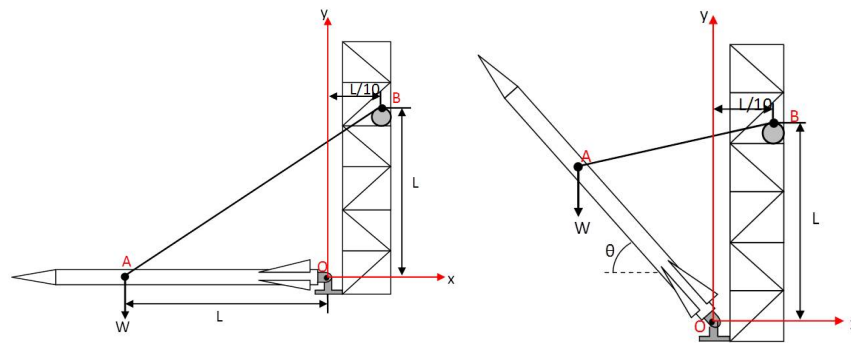
- Find the maximum value of distance  $d$  such that the system does not topple about point C.
- The ground at A can only support a load of 300 N. What is the minimum value of distance  $d$  such that the normal reaction force at point A does not exceed 300 N?



2. A large rocket is assembled and taken to the launch pad in a horizontal orientation. To prepare it for launch, it must be hoisted into a vertical position at the launch tower using an electric winch. The initial geometry is shown in the left diagram below. The rocket has a bracket at its base which is connected to the ground via a frictionless pin at the origin  $O$ . The cable first contacts the winch spool at point  $B$  located at  $(L/10)\mathbf{i} + L\mathbf{j}$  (assume  $B$  does not move as  $\theta$  changes). The cable from the winch is connected to the rocket's center of gravity, located initially (when  $\theta = 0^\circ$ ) at  $-L\mathbf{i}$ . Assume that the hoisting action begins instantaneously and is carried out at a constant speed (such that both the net force and net moment acting on the rocket are always zero). The geometry after the rocket has been hoisted to an angle  $\theta$  is shown in the right diagram below.

- If the rocket weighs 20,000 lbs and  $L = 24\text{ft}$ , find the tension in the cable and the reaction at the origin when  $\theta = 40^\circ$ .
- For what value of  $\theta$  is the tension in the cable  $T$  the highest? Also compute the maximum tension  $T_{max}$ .
- You are the engineer in charge of sizing the parts for the winch. You may choose from a selection of three motors two spools:
  - Motor A costs \$4,000 and has a maximum torque of 25,000 lb-ft
  - Motor B costs \$5,000 and has a maximum torque of 35,000 lb-ft
  - Motor C costs \$6,000 and has a maximum torque of 50,000 lb-ft
  - Spool X costs \$1,000 and has a diameter of 2 ft
  - Spool Y costs \$2,000 and has a diameter of 3 ft

Find the cheapest viable combination of motor and spool for the winch.



3. Book problems:

- (a) 4.5
- (b) 4.18
- (c) 4.69

Additional Practice Problems: 4.7, 4.13, 4.23, 4.28, 4.70, 4.84, 4.90

The quiz problem will not be selected from these additional practice problems. However, these exercises contain important elements of the course and similar problems may appear on the exam.