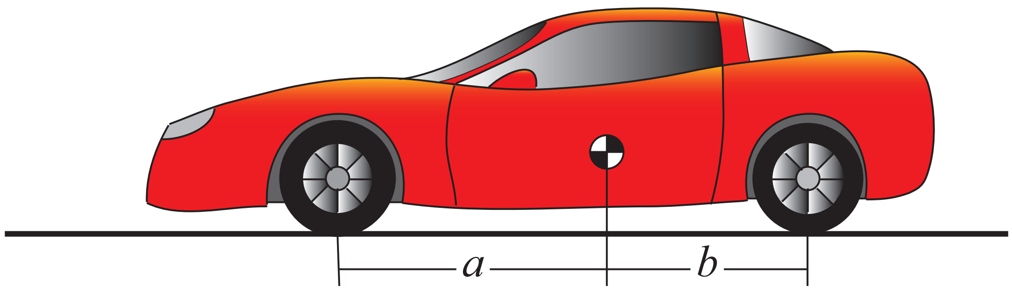
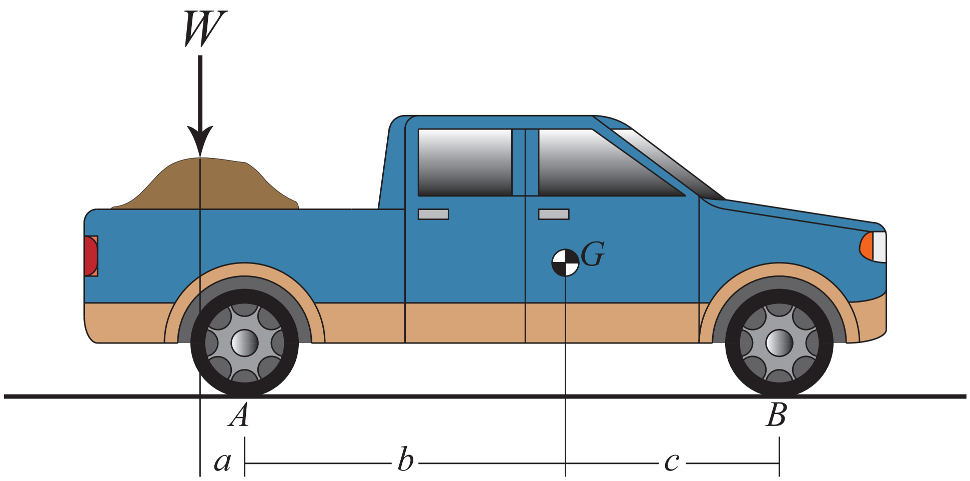
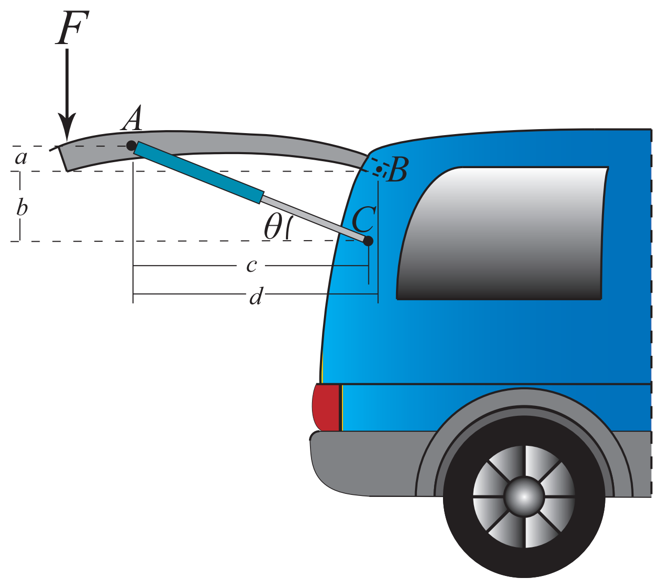
8.1 Let's start with a simple problem. Determining the forces on the front and rear tires of car that weighs 2400 lbs. You may assume that $a = 2.15ft.$ and $b = 2.65ft.$. What error do you obtain if you assume that the car is a point mass and all four wheels carry the same load?



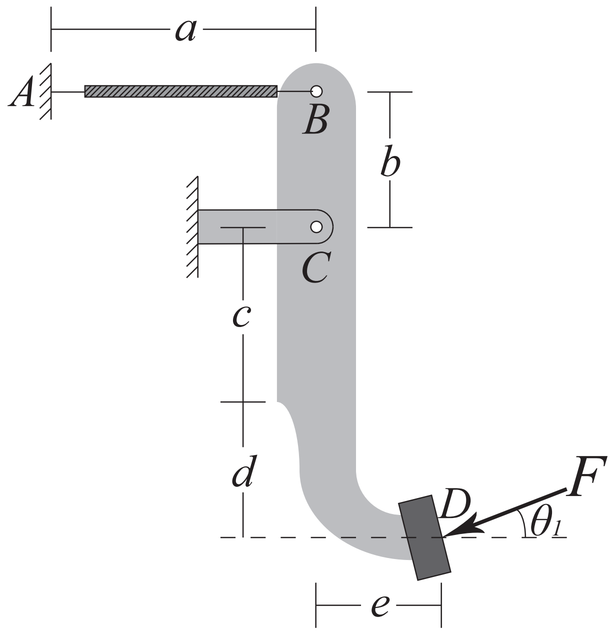
8.2 In this case, we will assume that the truck weighs 3900 lbs. and the load it is carrying weighs 750 lbs. Does the truck tip over? You may assume, $a = 0.45ft.$, $b = 3.1ft.$, and $c = 2.6ft.$.



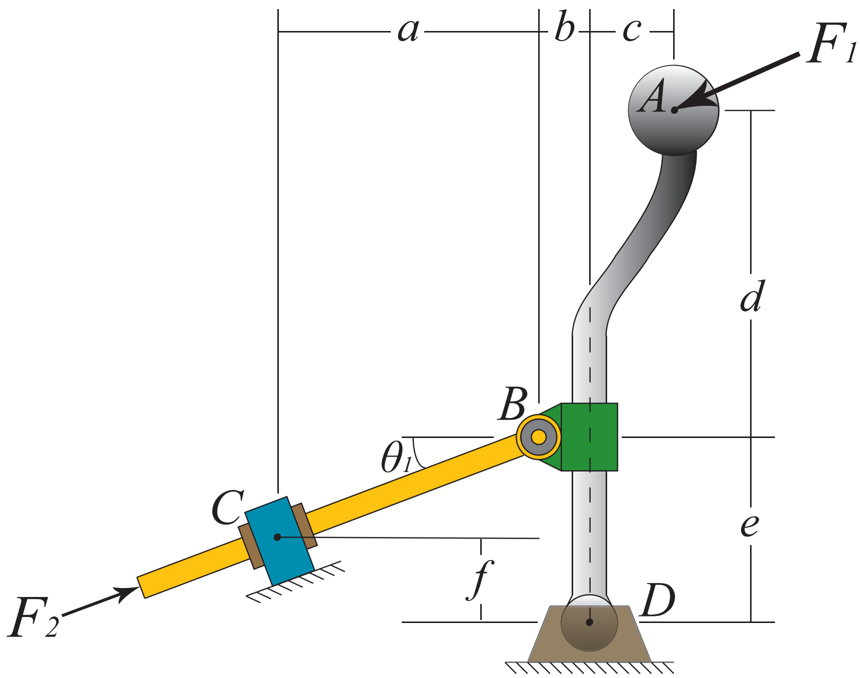
8.3 Shown below is a novel van hatch mechanism being closed. As a design exercise, determine the necessary force in each of the two hydraulic struts AC if the downward force F = 10 lbs. The mass center of the 90 lb. door is 1.5 inches directly below point A. Treat the problem as two-dimensional. The dimensions, a, b, c, and d are 2.5 in., 9 in., 3.5 ft, and 3.7 ft., respectively. The horizontal distance between F and point A is 7 in.



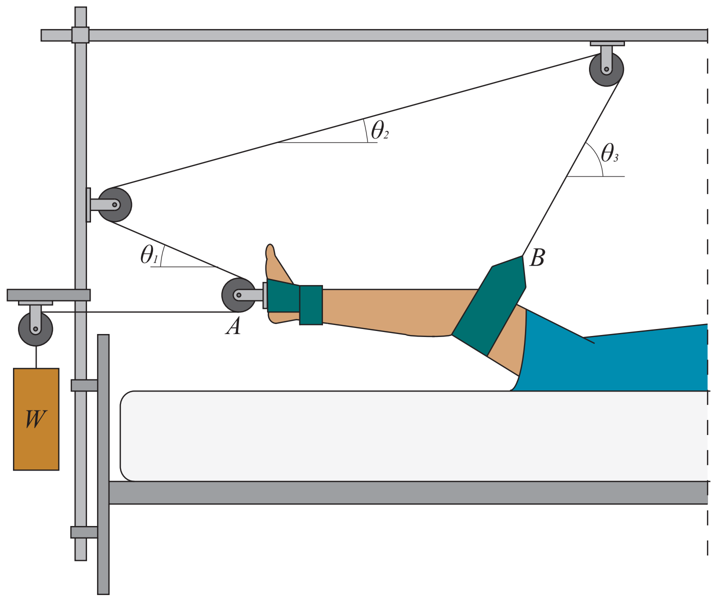
8.4 If the force applied to the brakes is 100 N, and the dimensions, a, b, c, d, and e are 6 cm, 3 cm, 4 cm, 2.8 cm, and 4 cm, respectively. The angle θ_L is 25^o. If the spring constant (link AB) is 10,000 N/m, how much deflection occurs at point B when the brakes are applied.



8.5 A portion of the shifter mechanism of a manual car transmission is shown in the figure. For the 3.75 lb. force exerted on the shift knob (it makes an angle with the horizontal of 30^o, determine the corresponding force F_2 exerted by the shift link BC on the transmission (not shown). Neglect friction in the ball-and-socket joint at D, in the joint at B, and in the slip tube near support C. Note that a soft rubber bushing at C allows the slip tube to self-align with link BC. The dimensions a, b, c, d, e, and f are 8 in., 0.5 in., 1.25 in., 7.25 in., 3.8 in., and 1 in., respectively.



8.6 Below is a traction system to keep the lower leg in place. For our purposes, we will assume that the muscles of the leg are relaxed and that we can model the knee as a pin joint. If all the pulleys are ideal pulleys, $\theta_1 = 30^o$, $\theta_2 = 20^o$, $\theta_3 = 50^o$, the length of the lower leg is 17 inches, the weight of the lower leg is 14 lbs.[6], and the applied load, W, is 50 lbs., what are the forces at the knee?

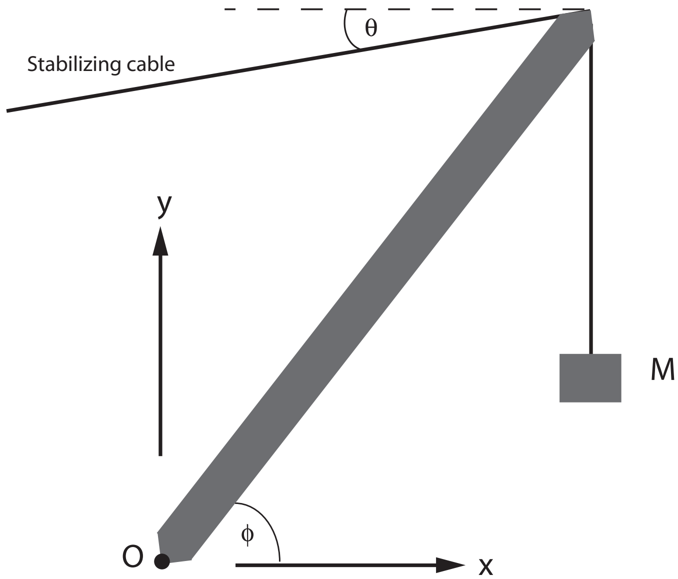


[6]You may assume it acts at the midpoint of the leg.

8.7 The crane shown below is capable of lifting 2,200 tons and was used to recover part of a South Korean navy combat corvette (The Cheonan) that was destroyed by conventional torpedoes (presumably fired by North Korean forces) in 2010. For this problem, we will focus on a simplified model of the boom.

The mass of the boom is assumed to be approximately 40,000 kg while the mass of the load it is raising is approximately M = 1,200 tonnes[7]. The base of the boom is secured by a giant pin joint. N.B. The cables at the end of the boom are NOT connected by pulleys. There should be different tensions in each.

[7] Note the difference between tonnes and tons.



Draw a free body diagram of the cranes boom.

If the boom is 250 m long, $\phi = 55^o$, and $\theta = 35^o$, determine the force in the stabilizing cable.

Determine the reactions at point O and write them in vector form.

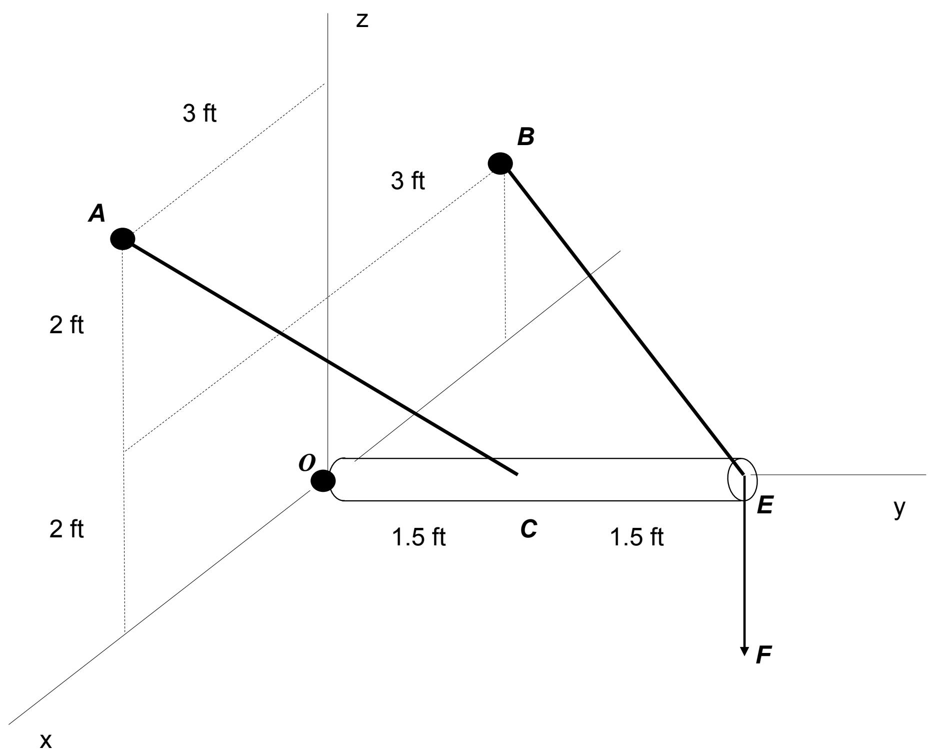
If the pin joint at O fails when it reaches a load of 2,500 kN, will the crane be able to lift this load safely?

8.8 Pole OE is supported by a ball-and-socket joint at O and cables AC and BE. A downward vertical force F acts at end E. Consider the weight of the pole to be negligible and the ball-and-socket joint at D to be frictionless.

Complete the free body diagram of the pole given below.

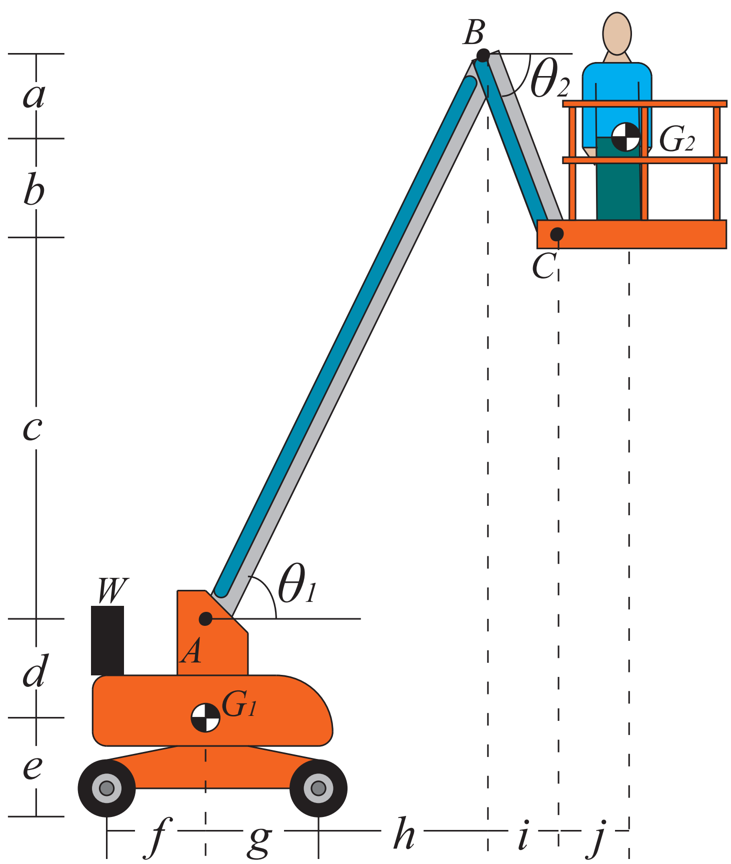
Resolve the forces of cables AC and BE on the pole in terms of their unknown magnitudes and known unit vectors.

If F = 1000 lb, find the tension in cables AC and BE.

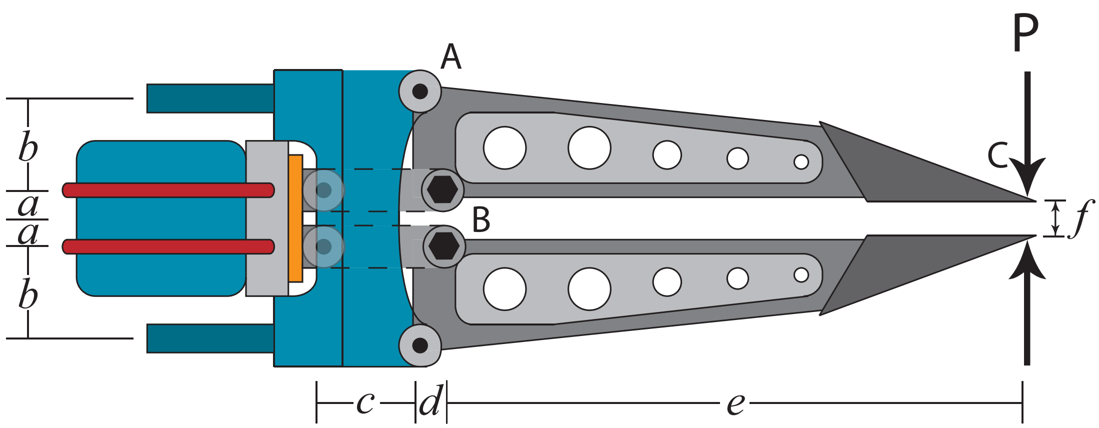


8.9 Rescue workers perform some of the most extreme tasks we can conceive of despite the fact that there is very little engineering knowledge related to the dangers they might face. The types of equipment available are severely limited. For instance, most computer processors and integrated circuits do not withstand high temperatures or extreme vibration. Similarly, pneumatic and hydraulic powered tools may fail when exposed to extreme environments. These next two problems will focus on understanding the mechanics of tools used by rescuers in a variety of scenarios.

First up is a problem in which the portable platform is used to work on dangerous high wire electrical systems or to force water into the 2nd story of a burning house. Important points when using these types of platforms is to ensure that they do not fall over and remain electrically isolated from the truck that positions them. Otherwise it is possible for the entire system to become electrified. The base has a weight of 500 lbs. and the maximum allowable weight in the basket is 450 lbs. Determine the size of the counterweight, W, that will just balance the load (it is positioned just about the left tire). The important distances are, $a = 2ft.$, $b = 3ft.$, $c = 12ft.$, $d = e = 2.5ft.$, $f = g = 3ft.$, $h = 7ft.$, and $i = j = 2.5ft.$

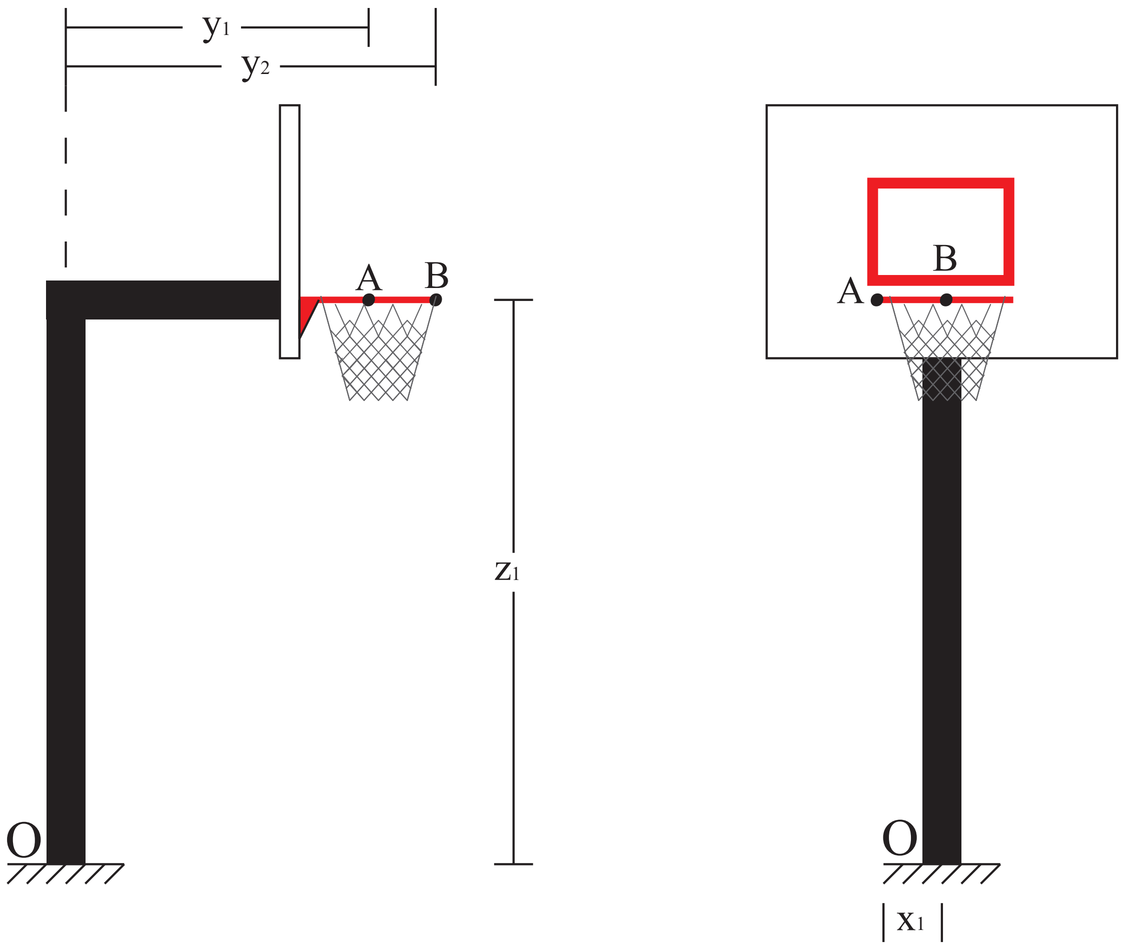


8.10 The "Jaws of Life" are one of the greatest developments in rescue technology. They are typically powered pneumatically[8] and generally used to release car accident victims from their automobiles or similar situations. For this application, we want to push against the wreckage with a force $P = 2000lbs$. (the force the wreckage exerts back on the Jaws of Life is shown in the figure). If we look at the upper jaw, pin A is meant to stay fixed while the piston pushes at point B (half the piston force goes to the upper jaw and half to the lower jaw). If the distances, a, b, c, d, and e are 0.5 in., 2.5 in., 2.5 in, 0.5 in., and 12 in., respectively, determine the reactions at A and B. Do the Jaws of Life operate at a mechanical advantage or disadvantage?

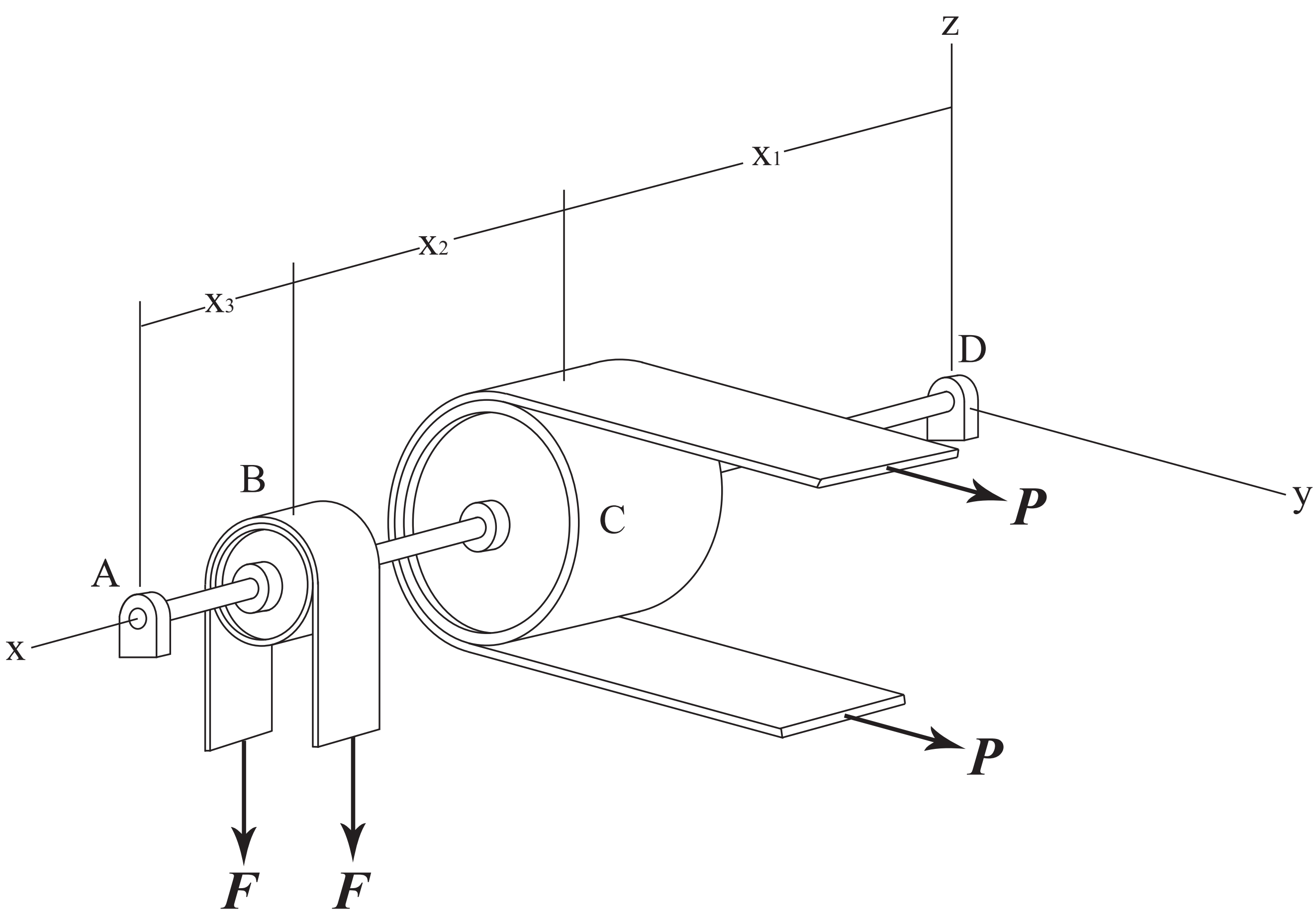


[8]In case we haven't covered it in class yet, pneumatic actuation is delivered by high pressure air while hydraulic loads are delivered with high pressure fluid (often oil). They each have advantages and disadvantages, but you definitely do not want to mix them up.

8.11 Below is a basketball goal with some typical (though not necessarily regulation) dimensions. The height of the rim is 10 ft. and the distance from the main support to point B (denoted by the distance y_2) is 4.5 ft. If Kevin Garnett (playing weight = 253 lbs.) dunks and hangs on the front of the rim, what are the reactions at the base of the post where it is cantilevered into the ground?



8.12 What we have here is a belt drive system as it is being readied for service. Before the belts can start turning, they must be tensioned and, in this case, the tensions are the same on both sides of each belt (*i.e.* they are acting as ideal pulleys). If point D acts as a thrust bearing and point A is a regular journal bearing, what are the reactions at A and D? You may assume that $F = 3,000N$ and $P = 1,200N$. The distances, x_1, x_2, and x_3 are 0.5 m, 0.4 m, and 0.25 m, respectively. The drive at B has a diameter of 0.1 m and the drive at C has a diameter of 0.22 m.



N.B. when the system is started up and the belt drives are moving, they will no longer act as ideal pulleys.