ENGINEERING BIOMECHANICS: STATICS[1]

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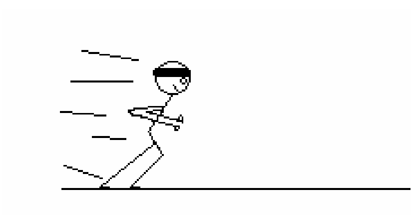
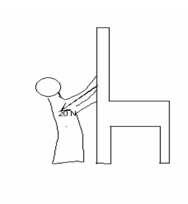
DIMENSIONS AND UNITS

1. A person on a diet might loose 2.3 kg per week. Express the mass loss rate in mg per second, as if the dieter could sense the second-by-second loss, [Halliday, Resnick and Walker 2003, 1N].

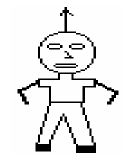
2. A man ran from a Marathon at a speed of about 23 rides per hour. The ride is an ancient Greek unit for length , as are the stadium and the plethron ; 1 ride was defined to be 4 stadia , 1 stadium was defined to be 6 plethra, and, 1 plethron is 30.8 m. How fast did the man runs in m/s?, [Halliday, Resnick and Walker 2003, 3].



3. A boy exerts a force of 20 N to push the chair. Change from SI units to US Customary units.

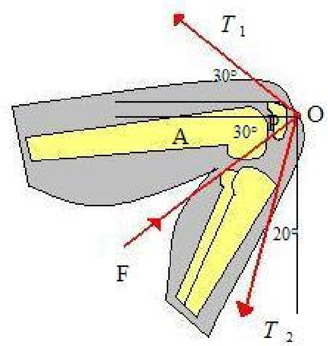


4. A boy grows at a rate of 1mm per day. How many cm would he grow in 2 years?

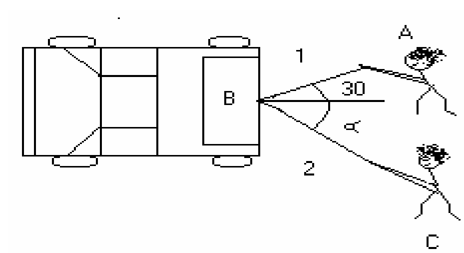


STATICS OF PARTICLES

1. The patella **P** located in the human knee joint is subjected to tendor forces $\mathbf{T_1}$ and $\mathbf{T_2}$, and a force **F** exerted on the patella by the femoral articula **A**. If the directions of these forces are estimated from an X-ray as shown, determine the magnitude of $\mathbf{T_1}$ and **F** when the tendor force $\mathbf{T_2}$ = 6 lbs. The forces are concurrent at point **O**, [Hibbeler 1992, 33].



2. Two men pull a car. If the resultant of the forces exerted by the men is 210 lb force directed along the axis of the car, determine; [a] the tension in each of the ropes knowing that alpha=45, [b] the value of alpha for which the tension in rope 2 is minimum, [Modified from: Beer and Johnston 2003, 33].



Numbers in the parenthesis refer to the appended references.

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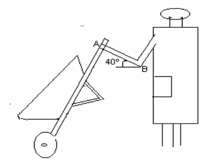
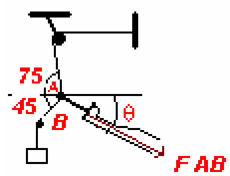
[2] The authors are in the alphabetical order.

3. While emptying a wheelbarrow, a gardener exerts a force of 70 N directed along line AB. Determine (a) the horizontal component, (b) the vertical component of the force, (c) the force in unit vector notation, and (d) the magnitude of the force, [Modified from: Beer and Johnston 2003, 33].

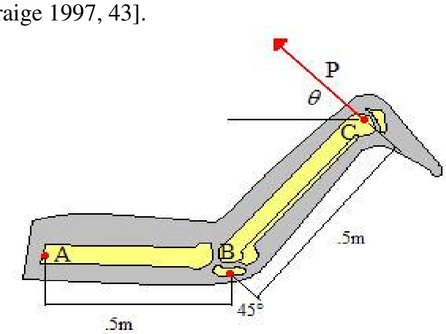


4. Determine the magnitude and direction of the resultant force F_{AB} exerted along link AB by the tractive apparatus shown. The suspended mass is 10 Kg. Neglect the size of the pulley at A, [Hibbeler 1992, 34].

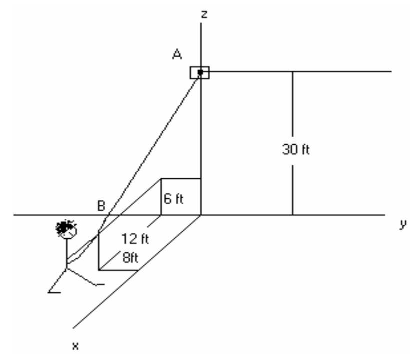


EQUIVALENT SYSTEM OF FORCES

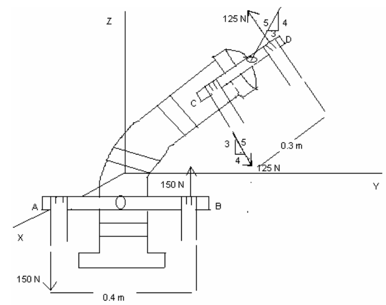
1. The 60-N force **P** is applied at the point **C** of the ankle, if θ = 45°, determine the moment of **P** about point **B** and point **A**. For what values of the angle θ will the moment about point **A** be a maximum? Determine this maximum value of moment of **A** about **B**, [Modified from: Meriam and Kraige 1997, 43].



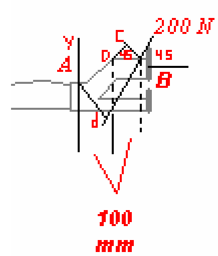
2. The man pulls on the cord with a force of 70 lb. Represent this force, acting on the support A, as a Cartesian vector and determine its direction, [Hibbeler 1986, 49].



3. Replace the two couples acting on the pipe column by a resultant couple moment, [Hibbeler 1995, 143].

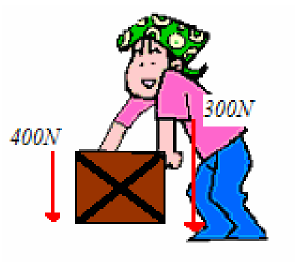


4. A 200 N force acts on the leg shown. Determine the moment of the force about point A, [Modified from: Hibbeler 1992, 105].

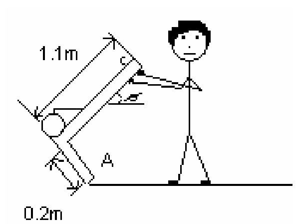


EQUILIBRIUM OF RIGID BODIES

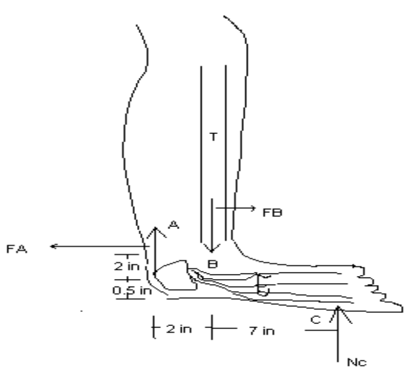
1. People often complaint about low back pains. But not many have wondered why they happen. The person shown here is lifting a box of 400 N. Find the force, $\mathbf{F_3}$, on the fifth lumbar vertebra caused by the wrong lifting of the box, [Broholm 1997, Internet].



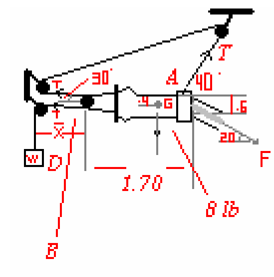
2. A modified peavey is used to lift a 0.2m diameter log of mass 3.6kg. Knowing that Ø=45 ° and that the force exerted at C by the worker is perpendicular to the handle of the peavey, determine the force exerted at C, (b) the reaction at A, [Beer and Johnston 2003, 189].



3. While slowly walking, a man having a total weight of 150 lb places all his weight on one foot. Assuming that the normal force Nc of the ground acts on his foot at C, determine the resultant vertical compressive force FB which the tibia T exerts on the astragalus B, and the vertical tension FA in the Achilles tendon A at the instant shown, [Hibbeler 1997, 175].

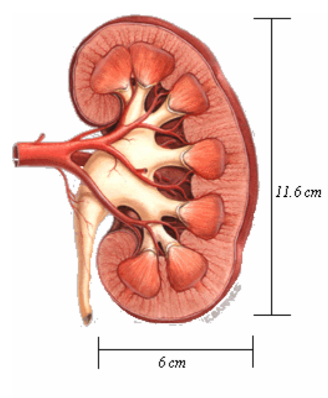


4. A Russell's traction is used for immobilizing femoral fractures C. If the lower leg has a weight of 8 lb, determine the weight W that the must be suspended at D in order for leg to be held in the position shown. Also what is the tension force F in the femur and the distance X that locates the center of gravity G of the lower leg? Neglect the size of the pulley al B, [Hibbeler 1992, 96].

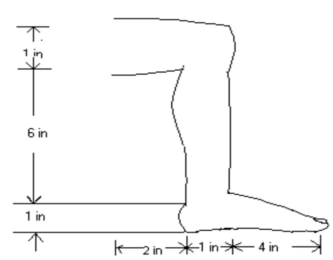


CENTROIDS AND CENTER OF GRAVITY

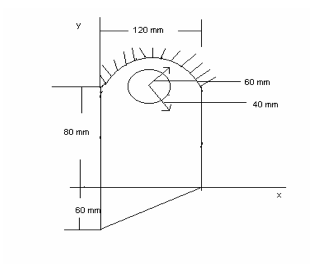
1. Approximate the location of the centroid of the kidney shown below. *Hint: Consider it has a constant thickness.*



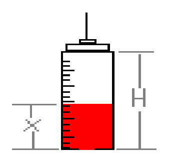
2. Find the centroid of the leg shown. Determine the second moment of area about the centroid axes parallel to the sides of the leg. Finally determine the product of area for the aforementioned centroid axes, [Modified from: Hibbeler 1986, 361-362].



3. For the plane area of the face shown that include one eye, determine (a) the first moments with respect to the x and y axes, (b) the location of the centroid, [Modified from: Beer and Johnston 2003, 228].

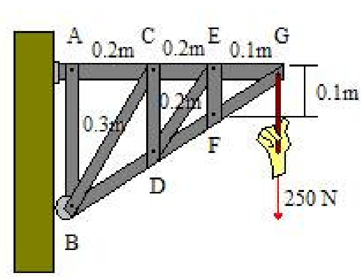


4. A needle can with mass M, height H, and uniform density is initially filled with blood of mass *m*. We punch small holes in the top and bottom to drain the blood; we then consider the height h of the center of mass of the needle and any blood within it. What is h initially and when all the blood has drained? What happens to h during the draining of the blood? If x is the height of the remaining blood at any given instant, find x (in terms of M, H, and m) when the center of mass reaches its lowest point, [Modified from: Halliday, Resnick and Walker 2003, 189].

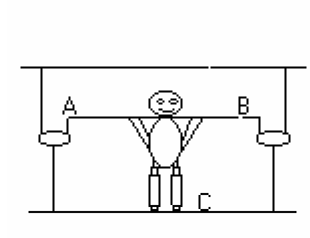


ANALYSIS OF STRUCTURES

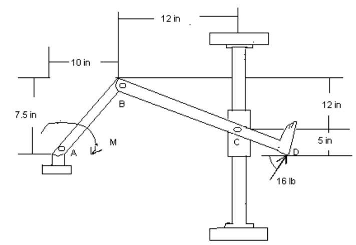
1. Following structure is used for the exercise of a hand. Compute the forces in members ***AB, BC*** and ***BD***. The hand is exerting a force of 250 N, [Modified from: Soutas-Little 1999, 310].



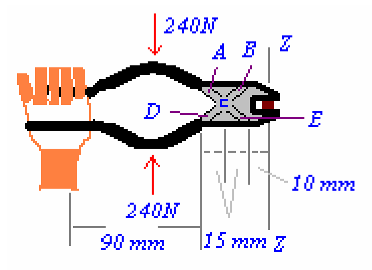
2. A man having a weight of **175 lb** attempts to lift himself using the method shown. Determine the total force he must exert on the bar **AB** and the normal reaction he exerts on the platform at **C.** The platform has a weight of **30 lb.**, [Hibbeler 1995, 293].



3. An artificial leg BCD is connected by pins to crank AB at B and to a collar at C. Neglecting the effect of friction, determine the couple M required to hold the system in equilibrium when θ = 45º, [Modified from: Beer and Johnston 2003, 336].

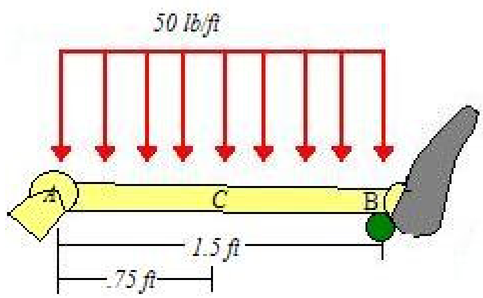


4. Determine the magnitude of the gripping forces exerted along line z-z on the nut when two 240-N forces are applied to the handles as shown. Assume that pins A and D slide freely in slots cut in the jaws, [Modified from: Beer and Johnston 2003, 338].

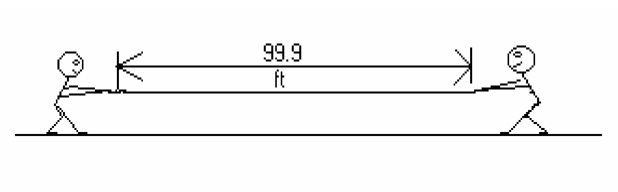


FORCES IN BEAMS AND CABLES

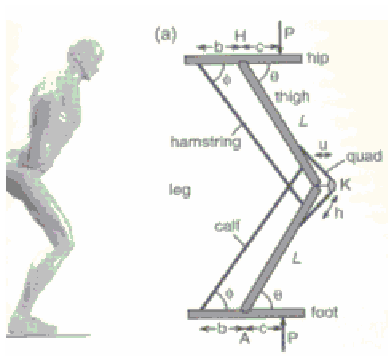
1. Find internal reactions at point C of the orthopedic leg below. The leg is lying over a ball, [Modified from: Beer and Johnston 2004, 372].



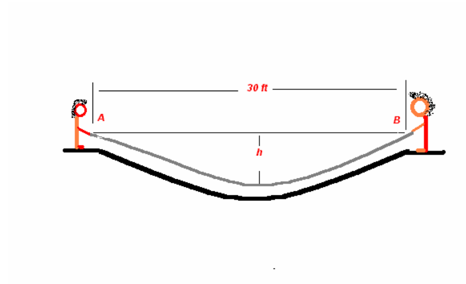
2. A steel tape used for measurement in surveying has a length of 100.0 ft and a total weight of 2 lb. How much horizontal tension must be applied to the tape so that the distance marked on the ground is 99.90 ft. The calculation should also include the effects of elastic stretching and temperature changes on the tape's length, [Hibbeler 1998, 362].



3. An athlete is performing squats to strengthen knee muscles. The movement is slow enough to assume static equilibrium. Consider the four-link system to represent the athlete during squatting. The beam representing the beam is connected to the rod representing the upper leg at the hip joint. A tension-carrying cord representing the calf muscles connects the foot to the thigh. The squad muscle connects the thigh and the leg through a frictionless pulley mechanism representing the patella joint. The joints at H, K and A are hinge joints. Determine the tension in hamstring, calf, and squads as a function of the angle the leg makes with the horizontal plane (θ), [Aydin Tözeren 2000, 166].

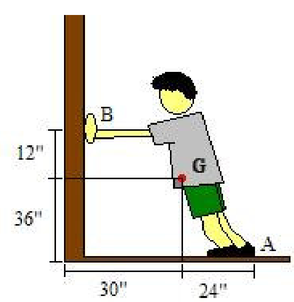


4. Two hikers are standing 30-ft apart and are holding the ends of a 35-ft length of rope as shown. Knowing that the weight per unit length of the rope is 0.05 lb/ft, determine (a) the sag h, (b) the magnitude of the force exerted on the hand of a hiker, [Modified from: Beer and Johnston 2003, 399].

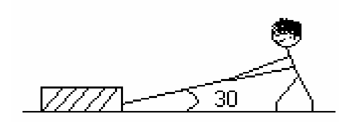


FRICTION

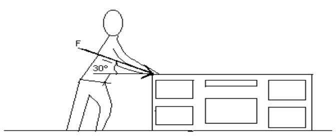
1. Before running, a jogger stretches his calf muscles by leaning against a wall as shown in the figure. This position is achieved with no vertical (friction) force acting between his hands and the wall. What is the minimum coefficient μ_S of static friction for which his feet will not slip? [Meriam and Kraige 1997, 399].



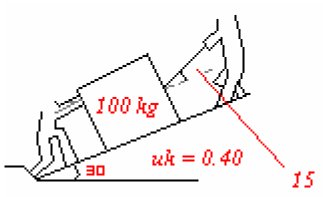
2. The coefficient of static friction between the person and the floor is **0.50** and the coefficient of static friction between the crate and the floor is **0.25** Determine the largest mass for the crate that the person can move by pulling on the cable if the person's mass is **70 kg,** [Ginsberg and Genin 1984, 12].



3. The uniform dresser has a weight of 80 lb and rest on a tile floor for which coefficient of static friction is 0.25. If the man pushes on it in the direction shown, determine the smallest magnitude of force F needed to move the dresser. Also if the man has a weight of 150 lb determine the smallest coefficient of friction between his shoes and the floor to avoid slippage, [Hibbeler 1983, 296].

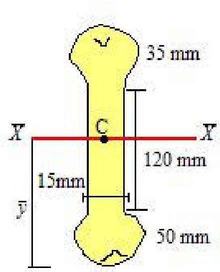


4. Two men are sliding a 100 Kg crate up an incline. If the lower man pushes horizontally with a force of 500 N and if the coefficient of kinetic friction is 0.40, determine the tension T that the upper man must exert in the rope to maintain motion of the crate, [Meriam and Kraige 1992, 359].

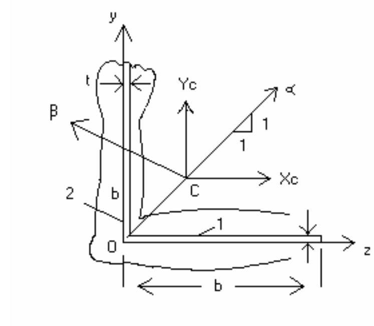


MOMENTS OF INERTIA

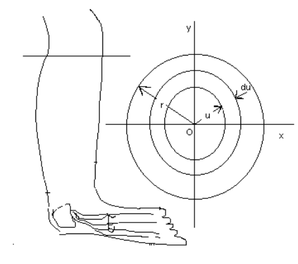
1. Determine the moment of inertia of the bone's cross-sectional area with respect to the $\bar{X}$ - $\bar{X}$ axis passing through the centroid **C** of the cross section, [Modified from: Hibbeler 1992, 147].



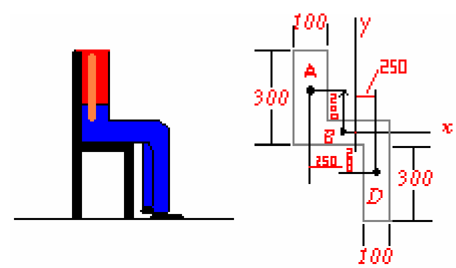
2. Find the moment of inertia of the arm shown. About the **alpha** and **beta** axes through its centroid **C.** The thickness **t** is very small compared to **b,** [Modified from: Shames 1997, 564-566].



3. (a) Determine the centroidal polar moment of inertia of a circular area of the leg by direct integration. (b) Using the results of part a, determine the moment of inertia of the circular area with respect to a diameter, [Modified from: Beer and Johnston 2003, 461].



4. Find Inertia Moment of the person along with the chair *(All dimensions in mm),* [Modified from: Hibbeler 1989, 452].



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