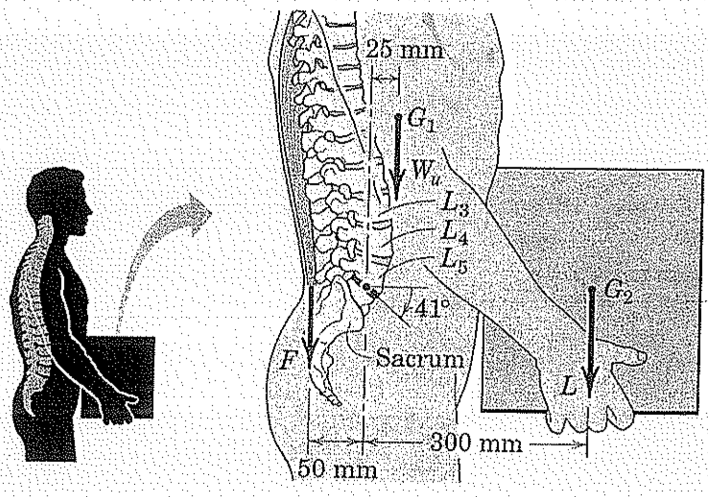
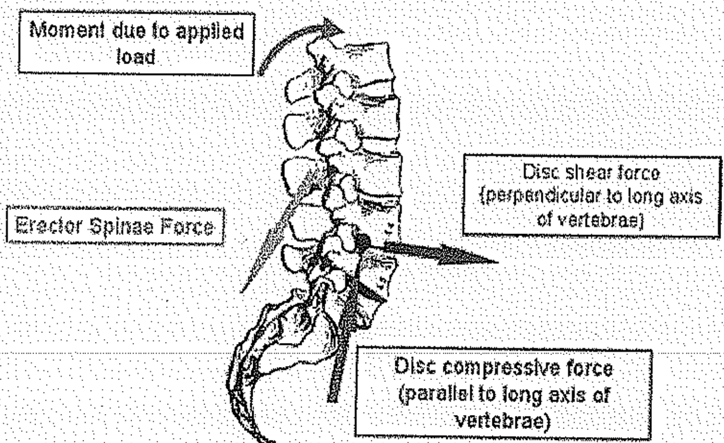
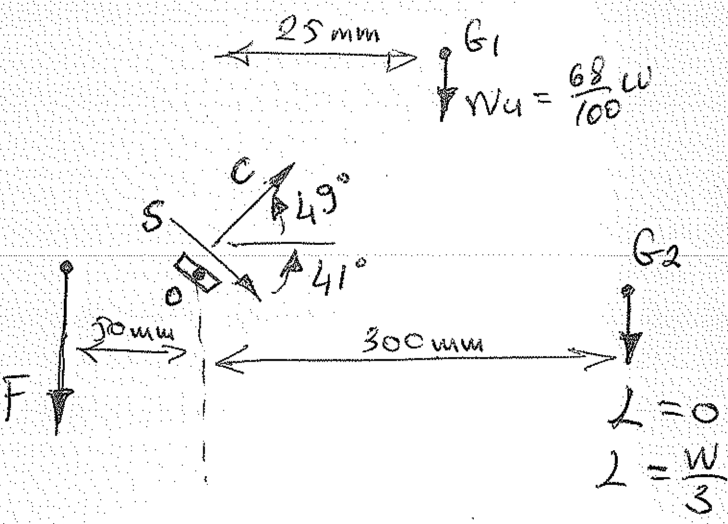


13. The lumbar portion of the human spine supports the entire weight of the upper torso and the force load imposed on it. We consider here the disk (shaded red) between the lowest vertebra of the lumbar region (L_5) and the uppermost vertebra of the sacrum region. (a) For the case L=0, determine the compressive force C and the shear force S supported by this disk in terms of the body weight W. The weight W_u of the upper torso (above the disk in question) is 68% of the total body weight W and acts at G_1. The vertical force F which the rectus muscles of the back exert on the upper torso acts as. (b) Repeat for the case when the person holds a weight of magnitude L=W/3. State any assumption.

Forces on the lumbar spine



Free Body Diagram.



Static Equilibrium Eqn^s

Case 1

$\Sigma \vec{F_x} = 0 \Rightarrow S.\cos 41° + C.\cos 49 = 0 \Rightarrow 0,75\,S + 0,65\,C = 0$

$\Sigma \vec{F_y} = 0 \Rightarrow -F - 0,68W - S.\sin 41 + C.\sin 49 = 0 \Rightarrow 0,75.C - 0,65.S = F + 0,68W$

$\Sigma \vec{M_o} = 0 \Rightarrow +F.50 - 0,68W * 25 = 0 \Rightarrow F = 0,34W$

$\Rightarrow \begin{array}{l} 0,75\,S + 0,65\,C = 0 \\ 0,75\,C - 0,65\,S = 1,02W \end{array} \Rightarrow \begin{array}{l} C = 0,77W \\ S = -0,66W \end{array}$

Case 2 $\quad \Sigma F_x = 0 \Rightarrow S.\cos 41° + C.\cos 49 = 0 \Rightarrow 0,75S + 0,65C = 0$

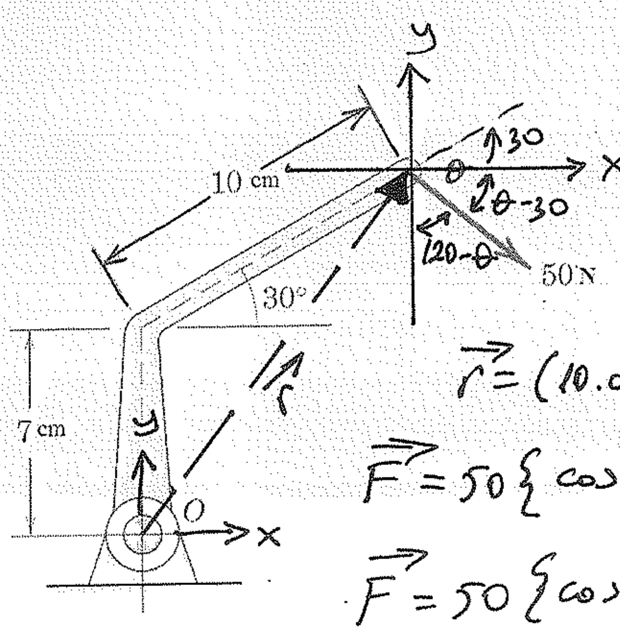
$\Sigma \vec{F_y} = 0 \Rightarrow -F - 0,68W - S.\sin 41 + C.\sin 49 - \frac{W}{3} = 0 \Rightarrow 0,75C - 0,65S = F + 1,01W$

$\Sigma \vec{M_o} = 0 \Rightarrow F.50 - 0,68W * 25 - \frac{W}{3}.300 = 0$

$F = 2,34W$

$\Rightarrow S = 2,2W$
$C = 2,53W$

(Meriam and Kraige, Statics)



11. Determine the angle which will maximize the moment *Mo* of the 50N force about the shaft axis at *O*. Also compute *Mo*.

$$\Sigma \vec{M_o} = \vec{r} \times \vec{F}$$

$$\vec{r} = (10.\cos 30 \vec{i} + 7 + 10 \sin 30 \vec{j}) = \{8,66 \vec{i} + 12 \vec{j}\} cm$$

$$\vec{F} = 50 \{\cos(\theta - 30)\vec{i} - \cos(120 - \theta)\vec{j}\} N$$

$$\vec{F} = 50 \{\cos(\theta - 30)\vec{i} - \sin(\theta - 30)\vec{j}\} N$$

$$\vec{M_o} = -443 \sin(\theta - 30)\vec{k} - 600 \cos(\theta - 30)\vec{k}$$

To calculate the maksimum value of Mo wrt θ, take the derivative of Mo wrt θ and equal to zero.

$$\frac{dM_o}{d\theta} = 0 \Rightarrow -433.\cos(\theta - 30) + 600 \sin(\theta - 30) = 0$$

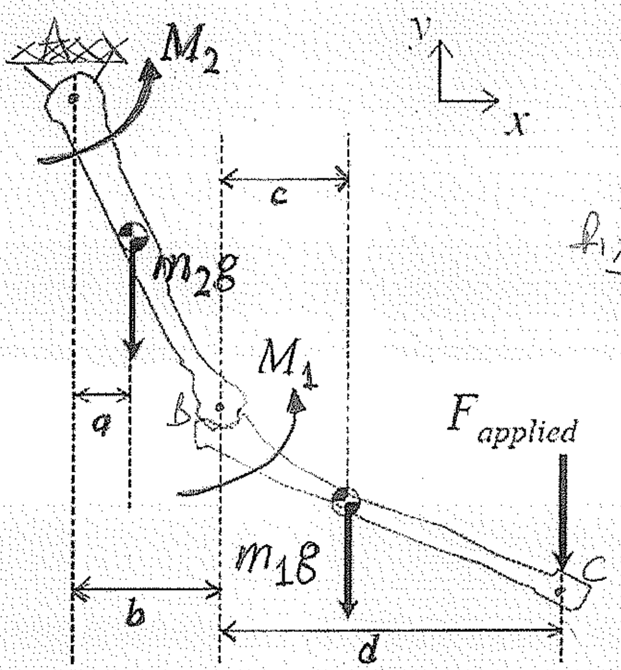
$$\tan(\theta - 30) = 0,721 \Rightarrow \theta = 65,79°$$

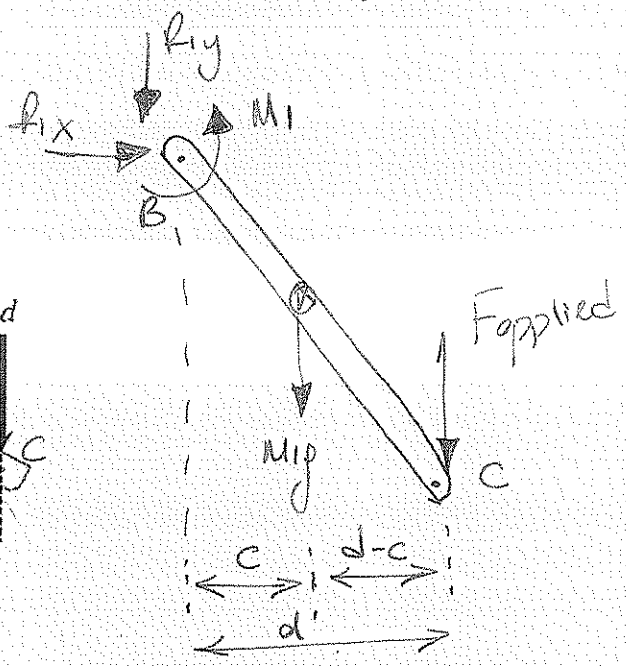
$$\Rightarrow \vec{M_o} = -433 \sin(5,76)\vec{k} - 600.\cos(5,76)\vec{k}$$

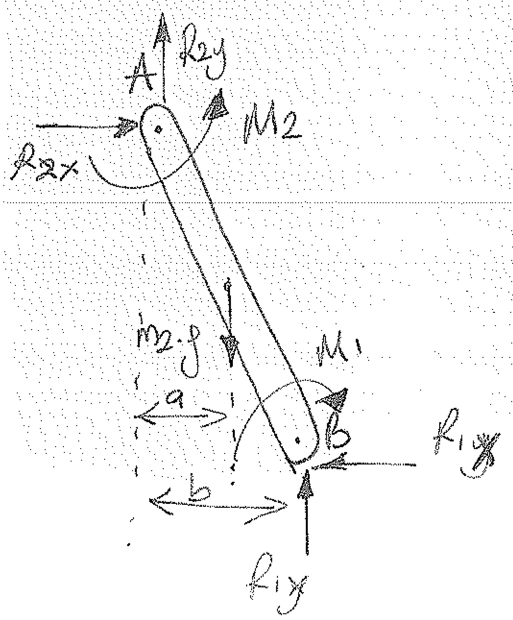
$$= 640,42 \, N cm$$

3.

Determine moments M_1, M_2 produced by upper limb muscle forces in the musculoskeletal system.







$$\sum \vec{F_x} = 0 \Rightarrow R_{1x} = 0$$

$$\sum \vec{F_y} = 0 \Rightarrow -R_{1y} - m_1 g - F_{ap} = 0$$

$$R_{1y} = -(m_1 g + F_{ap})$$

$$\sum \vec{M_B} = 0 \Rightarrow M_1 - m_1 g . c - F_{ap} d = 0$$

$$M_1 = F_{ap} * d + m_1 . g . c$$

$$\sum \vec{F_x} = 0 \Rightarrow R_{2x} - R_{1x} = 0 \Rightarrow R_{2x} = 0$$

$$\sum \vec{F_y} = 0 \Rightarrow R_{2y} - m_2 g + R_{1y} = 0 \Rightarrow R_{2y} = m_2 g + m_1 g + F_{ap}$$

$$\sum \vec{M_A} = 0 \Rightarrow M_2 - M_1 - m_2 . g . a + R_{1y} . b = 0$$

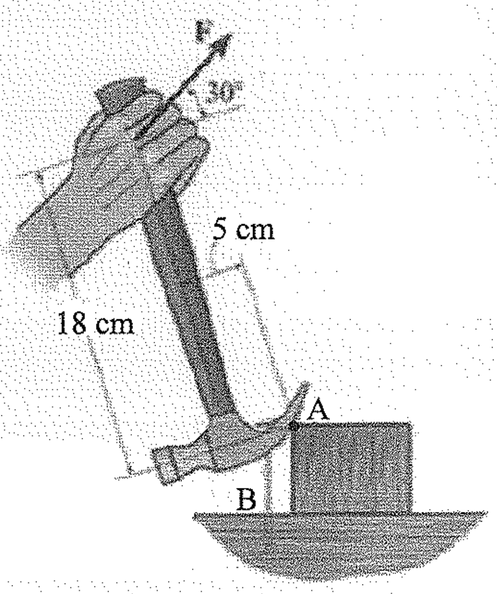
$$M_2 = M_1 + m_2 g . a - R_{1y} . b = F_{ap} * d + m_1 g . c + m_2 g . a + m_1 g b + F_{ap} . b$$

$$M_2 = F_{ap}(d + b) + m_1 g (c + b) + m_2 g . a$$

or, if it is not needed to analyze the dynamics of each link, just calculate the moments in well known simple approach.

$$M_1 = m_1 g\, d + F_{op} \cdot d$$

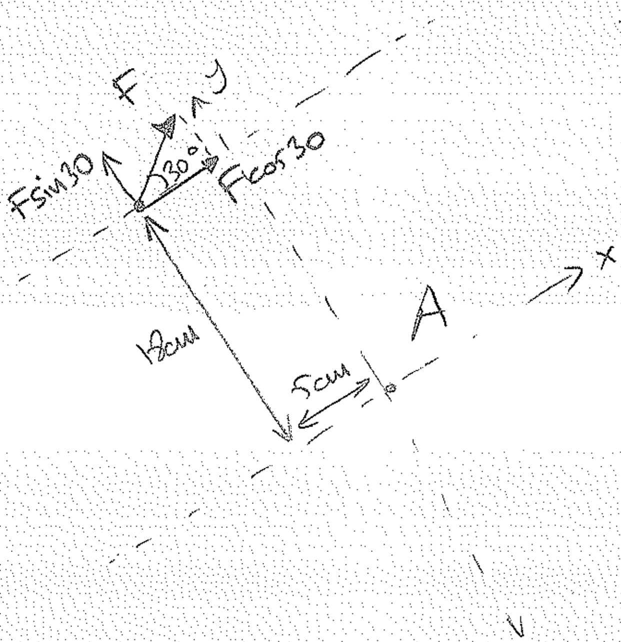
$$M_2 = m_2 \cdot g \cdot a + m_1 \cdot g \cdot (b+c) + F_{opp} \cdot (b+d)$$



In order to pull the nail at B, the force **F** exerted on the handle of the hammer must produce a clockwise moment of 500 Ncm about point A. Determine the required magnitude of F.

ÖRNEK 4- Çekiç-çivi moment sorusu.

ÇÖZÜM.



$$\Sigma M = 500 \text{ Ncm}$$

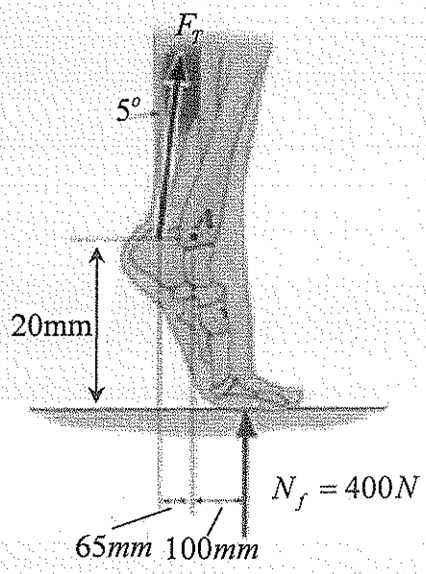
$$F\cos 30 * 18_{cm} + F\sin 30 * 5_{cm} = 500 \text{ Ncm}$$

$$\underbrace{F * 0{,}86 * 18}_{15{,}48} + F * \underbrace{0{,}5 * 5}_{2{,}5} = 500 \text{ Ncm}$$

$$17{,}98\, F = 500 \text{ Ncm}$$

$$F = 27{,}80 \text{ N.}$$

~~Önümüzdeki~~

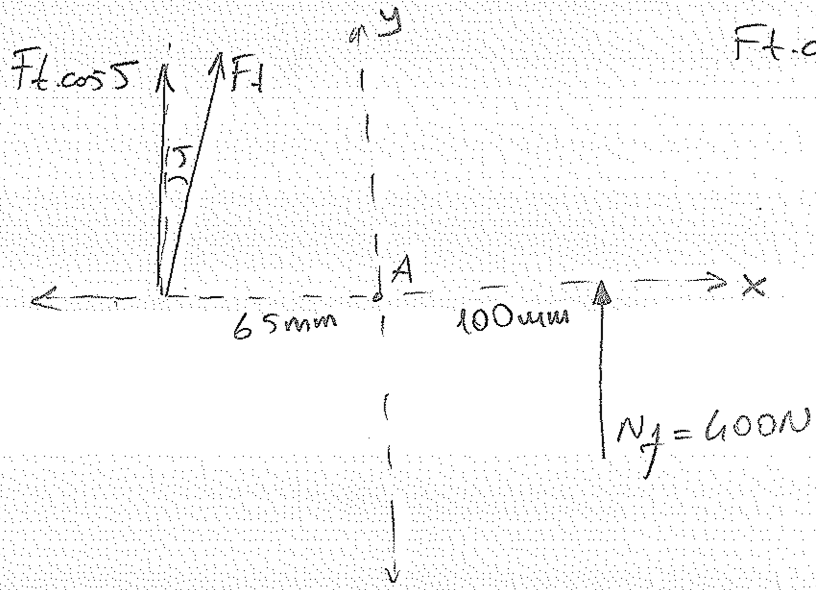


The Achilles tendon force $\boldsymbol{F_T}$ is mobilized when the man tries to stand on his toes. As this is done, each of his feet is subjected to a reactive force of N_f = 400N. If the resultant moment produced by forces $\boldsymbol{F_T}$ and N_f about the ankle joint A is required to be zero, determine the magnitude of $\boldsymbol{F_T}$.

ÖRNEK5 Ayok bileşinde oluşan momentin sıfır olması
ÇÖZÜM

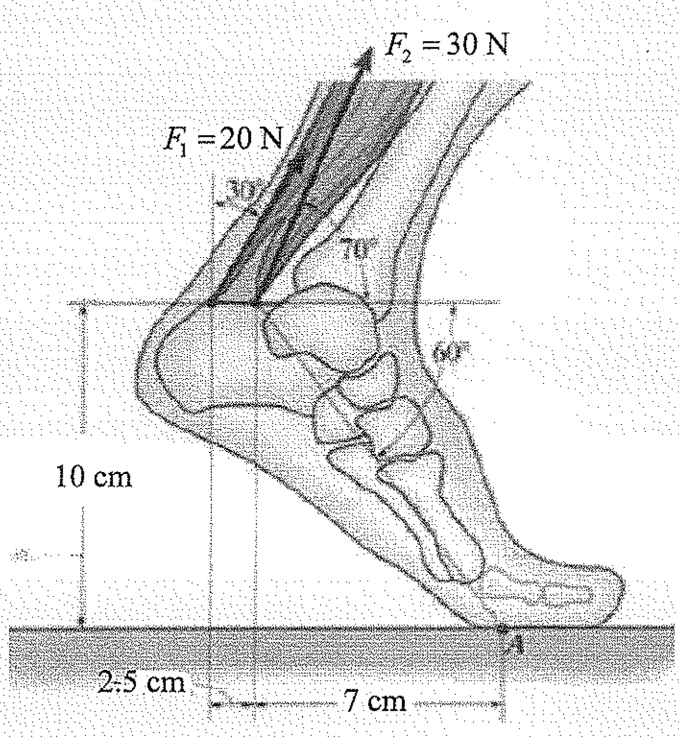
için $F_T = ?$ ↶+

$F_t \cdot \cos 5 = 0{,}996 F_t$



$$\Sigma M = 0 \Rightarrow -0{,}996 F_t * 65\,mm + 100\,mm \cdot 400\,N = 0$$

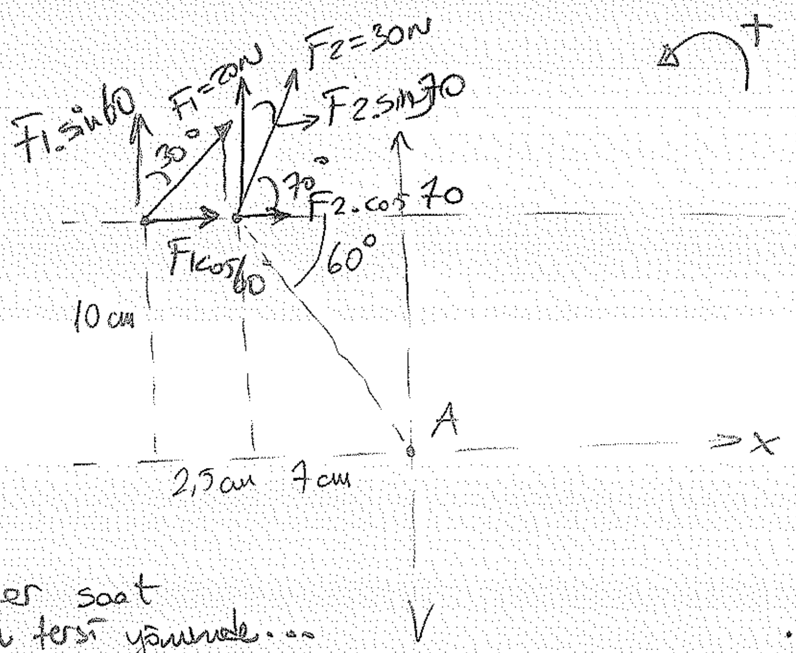
$$\Rightarrow F_t = 617{,}85\,N.$$



The foot segment is subjected to the pull of the two plantarflexor muscles. Determine the moment of each force about the point of contact A on the ground.

ÖRNEK-5 İ'lü plantarfleksör kasın çekmesine maruz kalan ayağın yere temas noktasındaki (A) momentin hesabı.

ÇÖZÜM

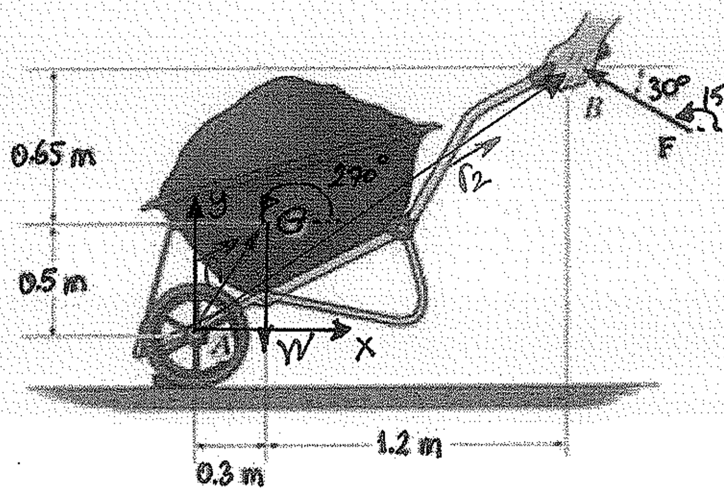


Tüm kuvvetler saat yönünün tersi yönünde...

$$\Sigma M_A = -F_2.\cos 70 . 10cm - F_2.\sin 70 . 7cm - F_1\cos 60 . 10cm - F_1\sin 60 . 9,5cm$$

$$\Sigma M_A = -30 . 3,42 - 30 * 6,57 - 20 * 5 - 20 * 8,22$$

$$\Sigma M_A = -102,6 - 197,1 - 100 - 164,4 = -564,1N$$



The wheelbarrow and its contents have a center of mass at G. If $F = 100$ N and the resultant moment produced by force F and the weight about the ankle at A is zero, determine the mass of the wheelbarrow and its contents.

Total moment about A is zero.

$$\Sigma \vec{M_A} = \vec{r_1} \times \vec{W} + \vec{r_2} \times \vec{F} = 0$$

$$= (0{,}3\vec{i} + 0{,}5\vec{j}) \times (W\cos 270\vec{i} + W\sin 270\vec{j}) + (1{,}5\vec{i} + 1{,}15\vec{j}) \times (F\cos 150\vec{i} + F\sin 150\vec{j})$$

$$\Sigma \vec{M_A} = -0{,}3W\vec{k} + 0{,}75F\vec{k} + 0{,}995F\vec{k} = 0$$

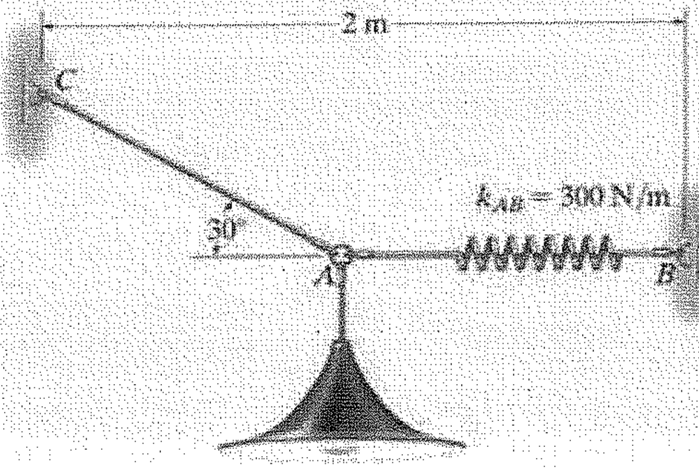
$$1{,}745F = 0{,}3W \Rightarrow W = 581{,}6\text{ N}$$

100N

2^{nd} way

$$\Sigma M_A = -W \cdot 0{,}3 + F\cos 30 \cdot 1{,}15 + F\sin 30 \cdot 1{,}5 = 0$$

$$0{,}3W = 99{,}59 + 75 \Rightarrow W \cong 581{,}9\text{ N}$$



Determine the required length of cord AC so that the 8-kg lamp can be suspended in the position shown. The undeformed length of the spring AB is $l_{AB} = 0.4$ m, and the spring has a stiffness of $k_{AB} = 300$ N/m.

$\Sigma \vec{F_x} = 0$

$-T.\cos 30 + F_s = 0$

$F_s = T.\cos 30$

T

30

$F_s = \Delta l * k$

$W = 8\,kg * 9{,}81\,\frac{m}{s^2} = 78{,}48\,N$

$\Sigma \vec{F_y} = 0$

$T\sin 30 - 78{,}48 = 0$

$T = 156{,}96$

$F_s = 135{,}93$

$135{,}93 = \Delta l * 300\frac{N}{m}$

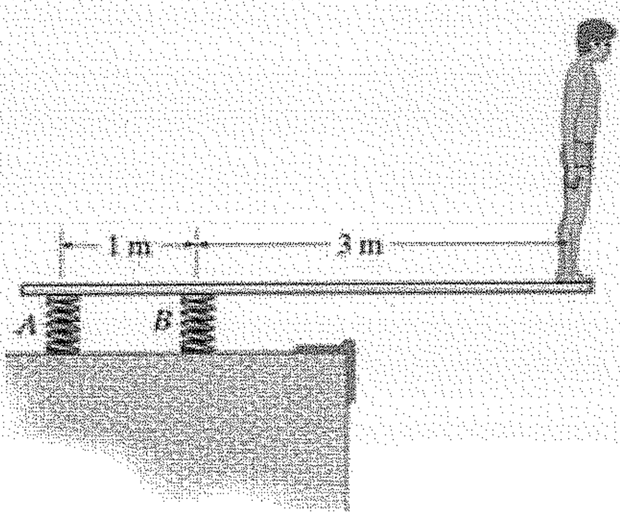
$\Delta l = 0{,}45\,m$

A' A B

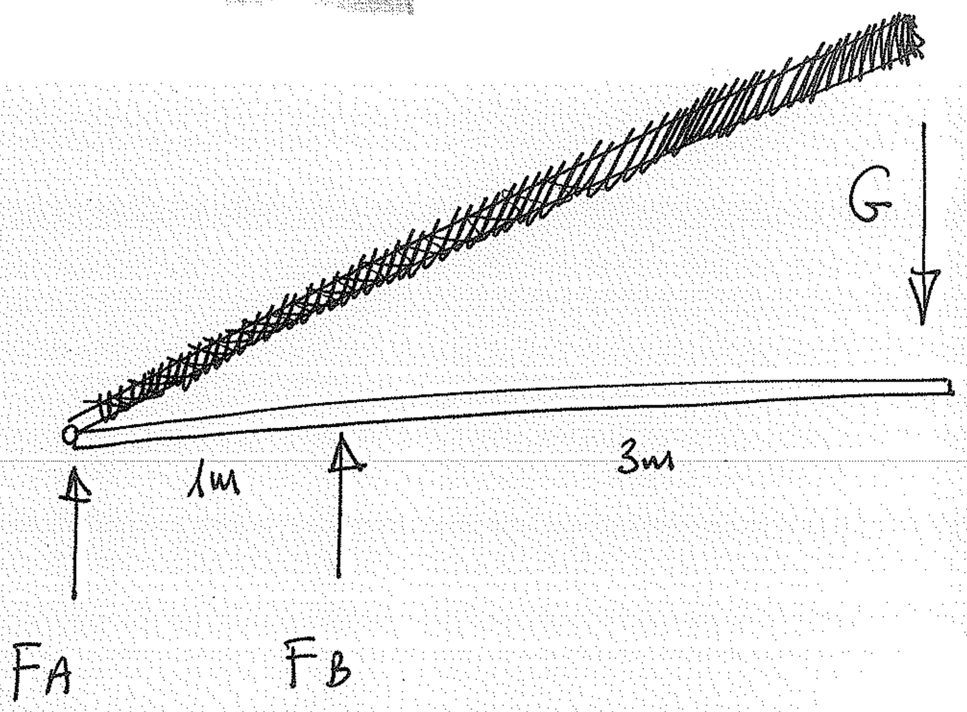
$2 - 0.45 - 0.4$ $\quad \Delta l = 0.45$ $\quad l_{AB} = 0.4m$

$= 1{,}15\,m$

$\Rightarrow l_{AC}.\cos 30 = 1{,}15 \Rightarrow l_{AC} = 1{,}32\,m.$



A man stands out at the end of the diving board, which is supported by two springs A and B, each having a stiffness of k=15 kN/m. In the position shown the board is horizontal. If the man has a mass of 40 kg, determine the angle of tilt which the board makes with the horizontal after he jumps off. Neglect the weight of the board and assume it is rigid. $\alpha \doteq 10,4^\circ$



$G = 40 \times 9,81 = 392,4N$

$\sum \vec{F_y} = 0$

$F_A + F_B - G = 0$

$F_A + F_B = 392,4N$

$\sum \vec{M_A} = 0$

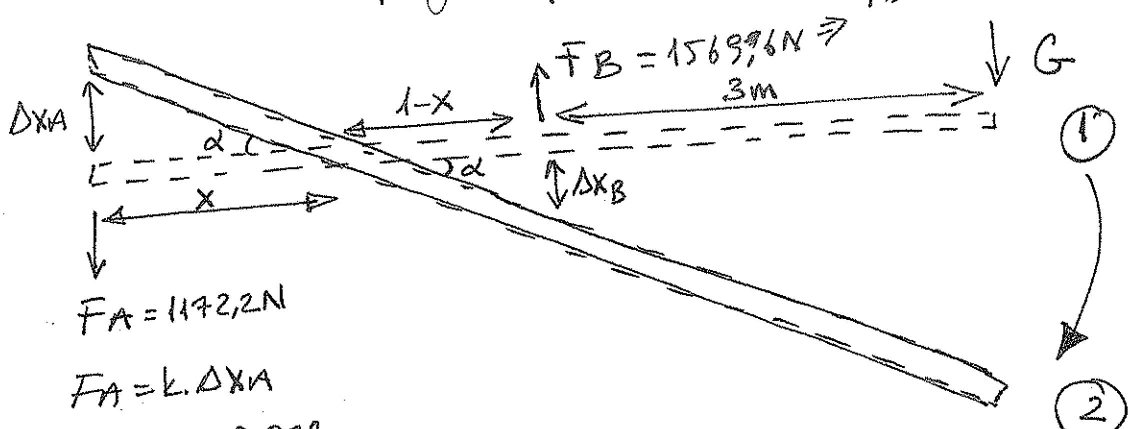
$F_B - 4G = 0$

$F_B = 1569,6\ N$

$F_A = -1172,2\ N$

At the time of jumping

$F_B = k.\Delta X_B \Rightarrow \Delta X_B = 0,104m$

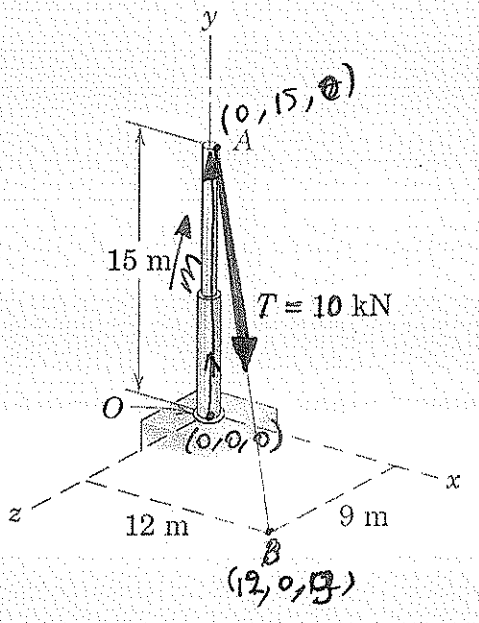


$F_A = 1172,2N$

$F_A = k.\Delta X_A$

$\Delta X_A = 0,078m$

$\tan\alpha = \dfrac{0,078}{X} = \dfrac{0,104}{1-X} \Rightarrow \quad X = 0,428 \quad \Rightarrow \alpha = A\tan\left(\dfrac{0,078}{0,428}\right) = 10,3^\circ$



8. A tension T of magnitude 10 kN is applied to the cable attached to the top A of the rigid mast and secured to the ground at B. Determine the moment M_z of T about the z-axis passing through the base O.

$\vec{T} = T.\vec{u} = T.\frac{\vec{r}}{|r|}$, $\vec{r}$: position vector

$\vec{r} = (12-0)\vec{i} + (0-15)\vec{j} + (9-0)\vec{k} = 12\vec{i} - 15\vec{j} + 9\vec{k}$

$|r| = \sqrt{144 + 225 + 81} = 21{,}21\,m$

$\Rightarrow \vec{T} = 10\,kN\,(0{,}56\vec{i} - 0{,}7\vec{j} + 0{,}42\vec{k})$

$\vec{m} = 15\vec{j} \Rightarrow \vec{M_o} = \vec{m} \times \vec{T} = 15\vec{j} \times (5{,}6\vec{i} - 7\vec{j} + 4{,}2\vec{k})$

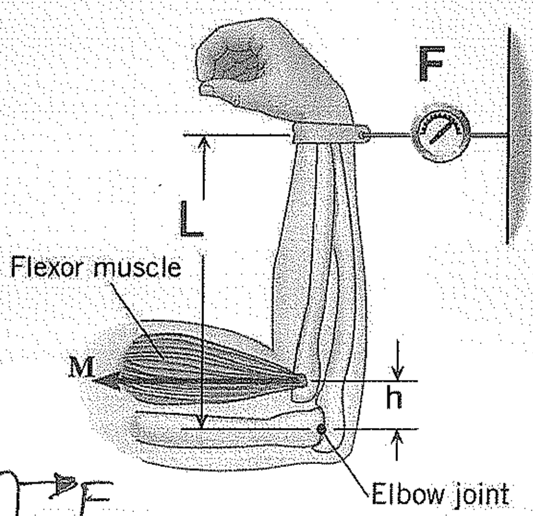
$= \{\underbrace{-8{,}4\vec{k}}_{\vec{M_z}} + \underbrace{6{,}3\vec{i}}_{\vec{M_x}}\}$ kNm.

$\vec{M_x}$: moment about X axis

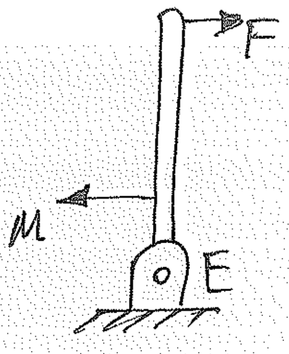
moment about z axis.

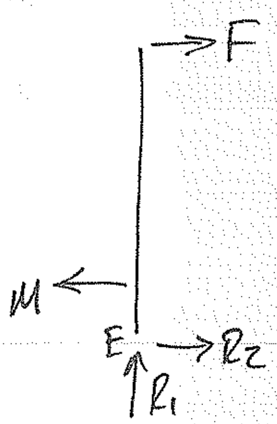
Rotational-Linear Parallels

	Linear Motion	Rotational Motion	
Position	x	θ	Angular position
Velocity	v	ω	Angular velocity
Acceleration	a	α	Angular acceleration
Motion equations	$x = \bar{v}t$	$\theta = \bar{\omega}t$	Motion equations
	$v = v_0 + at$	$\omega = \omega_0 + \alpha t$	
	$x = v_0 t + \frac{1}{2}at^2$	$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$	
	$v^2 = v_0^2 + 2ax$	$\omega^2 = \omega_0^2 + 2\alpha\theta$	
Mass (linear inertia)	m	I	Moment of inertia
Newton's second law	$F = ma$	$\tau = I\alpha$	Newton's second law
Momentum	$p = mv$	$L = I\omega$	Angular momentum
Work	Fd	$\tau\theta$	Work
Kinetic energy	$\frac{1}{2}mv^2$	$\frac{1}{2}I\omega^2$	Kinetic energy
Power	Fv	$\tau\omega$	Power



A person exerts a horizontal force $|F| =$ 150 N in the test apparatus shown in the drawing. Find the horizontal force M (magnitude and direction) that the flexor muscle exerts on his forearm (L = 0.30 m, h = 0.040 m), assuming the elbow can be modeled as a hinge joint.





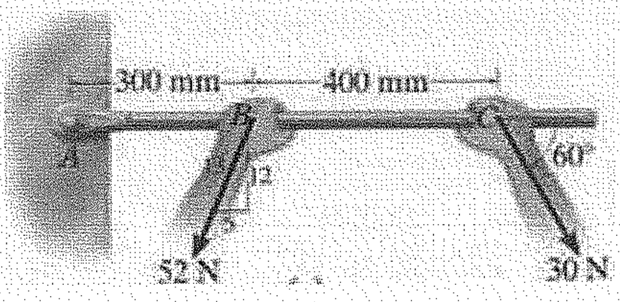
$\sum \vec{F_x} = 0 \Rightarrow F - M + R_2 = 0$

$\sum \vec{F_y} = 0 \Rightarrow R_1 = 0$

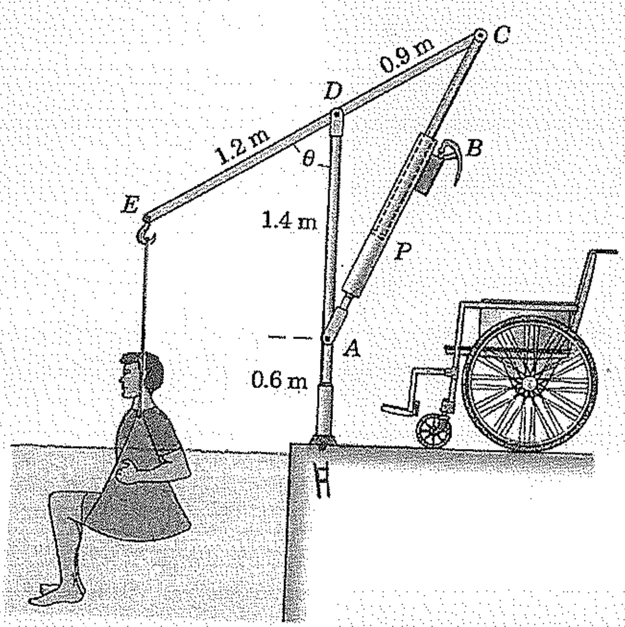
$\sum \vec{M_E} = 0 \Rightarrow -F * 0{,}3 + M * 0.04 = 0$

$M = 1125\ \text{N}$

$R_2 = 975$



The box wrench is used to tighten the bolt at A. If the wrench does not turn when the load is applied to the handle, determine the torque or moment applied to the bolt and the force for of the wrench on the bolt. ($A_x = 5N$ $M_A = 32{,}6\ Nm$
$A_y = 74N$ $F_A = 74{,}1\ N$)



The frame shown enables transfer of a 75kg disabled person to and from a wheelchair and a fresh-water swimming pool. A small hand pump at B pressurizes the upper end of the cylinder to control the tension and length of link AC. For the position $\theta = 60°$, link AC is under a tension of 670N. Calculate the volume of the submerged portion of the person. Neglect the weight of the frame assemby. Recall thath the density of fresh water is 1000 kg/m^3.

Sorunun devamı:

$F_{Buoyant}$ = weight of the fluid that is displaced by the object.

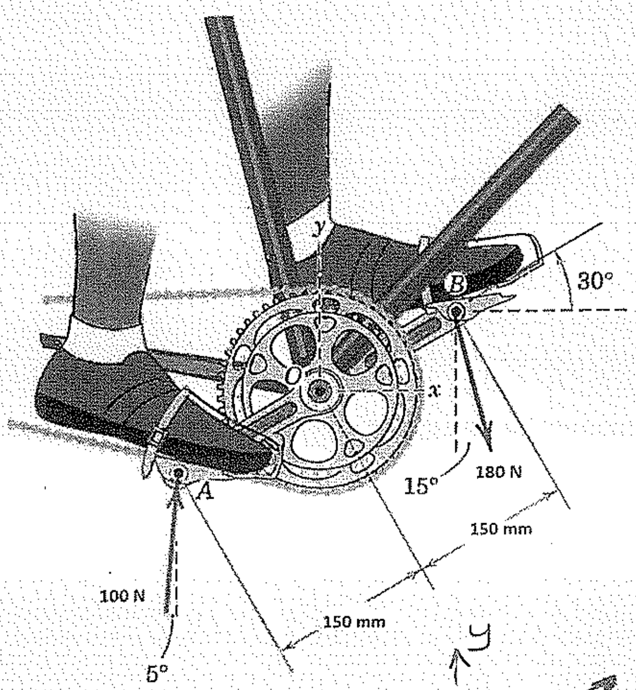
$$F_{Buoyant} = m \cdot g = \rho \cdot V_{submerged} \cdot g =$$

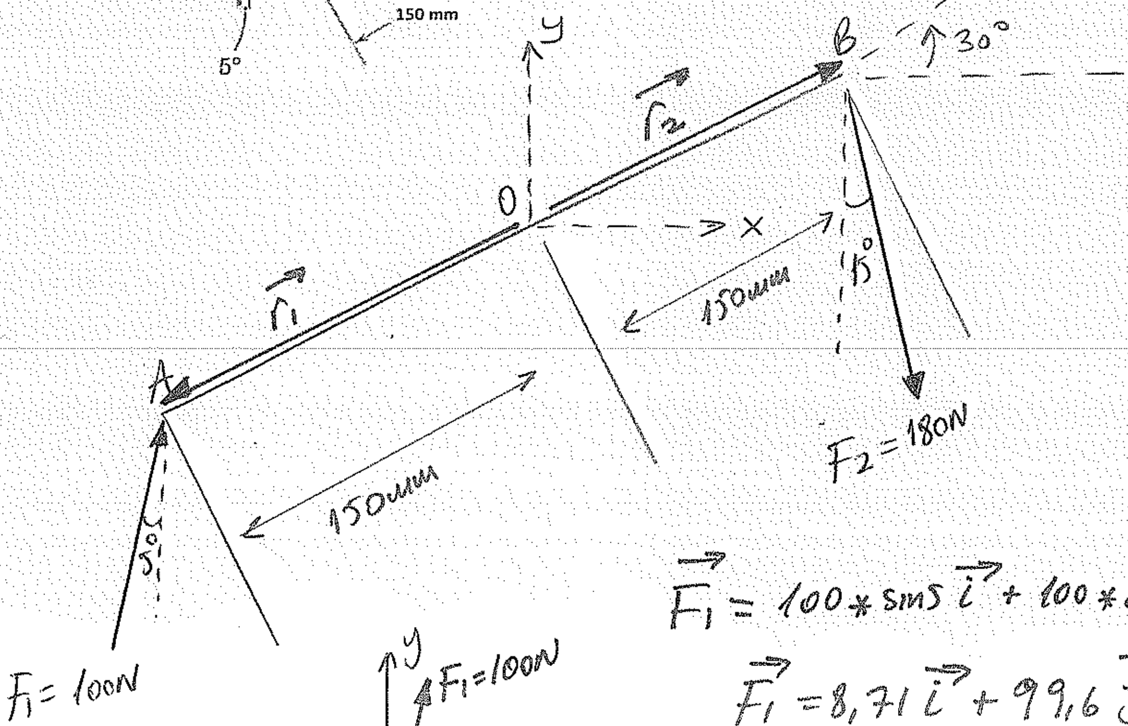
$$425{,}42 \frac{kg\,m}{s^2} = 1000 \frac{kg}{m^3} * V_{submerged} * 9{,}81 \frac{m}{s^2}$$

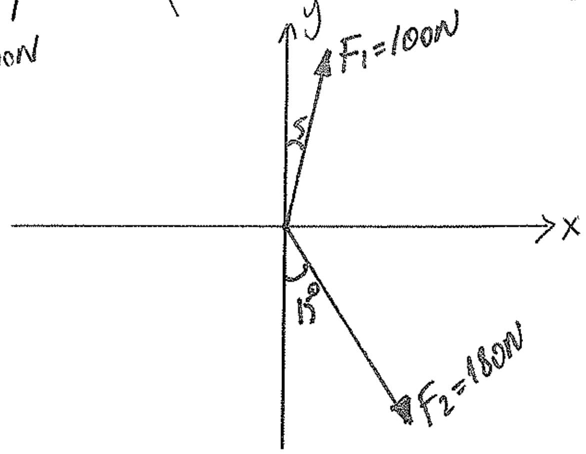
$$V = 0{,}043\ m^3$$

(Meriam P:65)

The pedal-chainwheel unit of a bicycle is shown in the figure. The left foot of the rider exerts the 180 N force, while the use of toe clips allows the right foot to exert the nearly upward 100 N force. Determine the equivalent force-couple system at point O. Also determine the equation of the line of action of the system resultant treated as a single force R. Treat the problem as two dimensional.







$$\vec{F_1} = 100 * \sin 5\, \vec{i} + 100 * \cos 5\, \vec{j}$$

$$\vec{F_1} = 8{,}71\, \vec{i} + 99{,}6\, \vec{j}$$

$$\vec{F_2} = +180 * \sin 15\, \vec{i} - 180 * \cos 15\, \vec{j}$$

$$\vec{F_2} = 46{,}5\, \vec{i} - 173{,}8\, \vec{j}$$

Equivalent Force: $\vec{R} = 55{,}21\, \vec{i} - 74{,}2\, \vec{j}$

$$\theta = \tan^{-1} \frac{R_y}{R_x} = \frac{-74{,}2}{55{,}21} =$$

$$\theta = 306{,}6°$$

Equivalent couple: $\vec{M} = \vec{M_1} + \vec{M_2}$

$$\vec{r_1} = -150 * \cos 30\,\vec{i} - 150 * \sin 30\,\vec{j} = -129{,}9\,\vec{i} - 75\,\vec{j}$$

$$\vec{r_2} = 150 * \cos 30\,\vec{i} + 150 * \sin 30\,\vec{j} = 129{,}9\,\vec{i} + 75\,\vec{j}$$

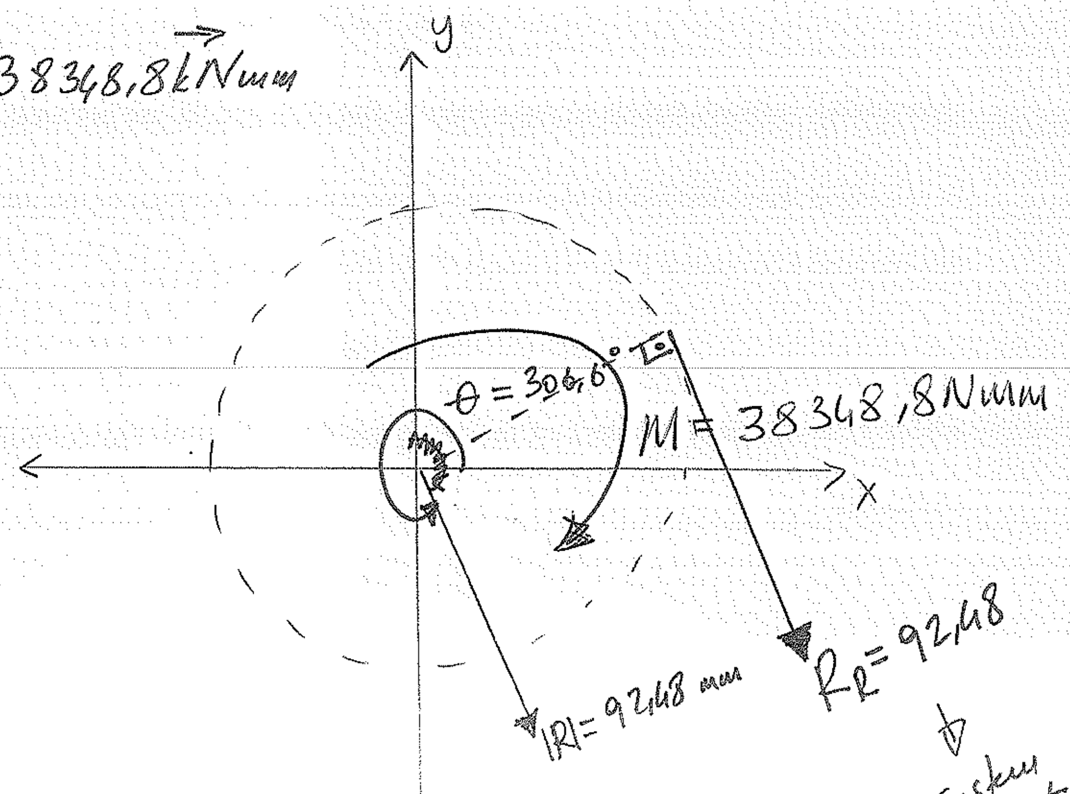
$$\vec{M_1} = \vec{r_1} \times \vec{F_1} = (-129{,}9\,\vec{i} - 75\,\vec{j}) \times (8{,}71\,\vec{i} + 99{,}6\,\vec{j})$$

$$\vec{M_1} = -12284{,}7\,\vec{k}\ (Nmm)$$

$$\vec{M_2} = \vec{r_2} \times \vec{F_2} = (129{,}9\,\vec{i} + 75\,\vec{j}) \times (46{,}5\,\vec{i} - 173{,}8\,\vec{j})$$

$$\vec{M_2} = -26064{,}1\,\vec{k}\ (Nmm)$$

$$\Rightarrow \vec{M} = -38348{,}8\,\vec{k}\,Nmm$$



↓ system resultant

$|R_R| = 92{,}48$

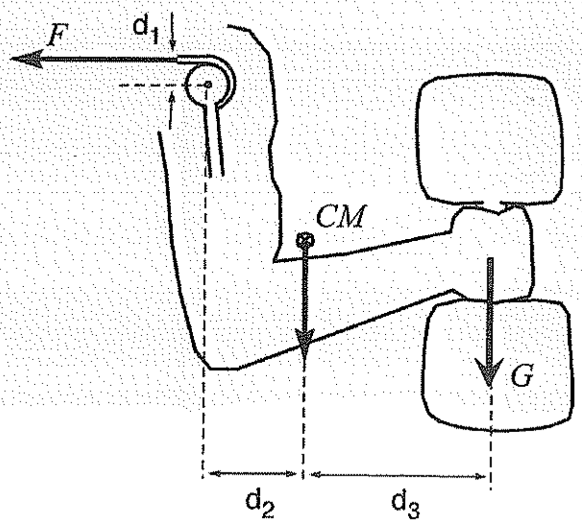
$$d * |R_R| = |M| \qquad d * \sqrt{55{,}21^2 + 74{,}2^2} = 38348{,}8$$

↓ System Resultant

$$d = 414{,}6\ mm$$

(Equation of line of action of the system resultant can be found by determining the intersection points of line between x and y-axes.)

Buradan, R_R kuvvetinin x ve y eksenini kestiği noktalar bulunup, denklem elde edilir.



In the drawing shown below, the subject is holding the dumbbell statically in place. The cross indicates the position of the center of mass (CM) of the upper-arm + forearm + hand system. The mass of the upper-arm + forearm + hand system was 7 kg, and the tension exerted by the shoulder muscle was 600 N. The values of the distances shown were: $d_1 = 0.04$ m, $d_2 = 0.20$ m and $d_3 = 0.31$ m. Calculate the upward force exerted by the hand on the dumbbell.

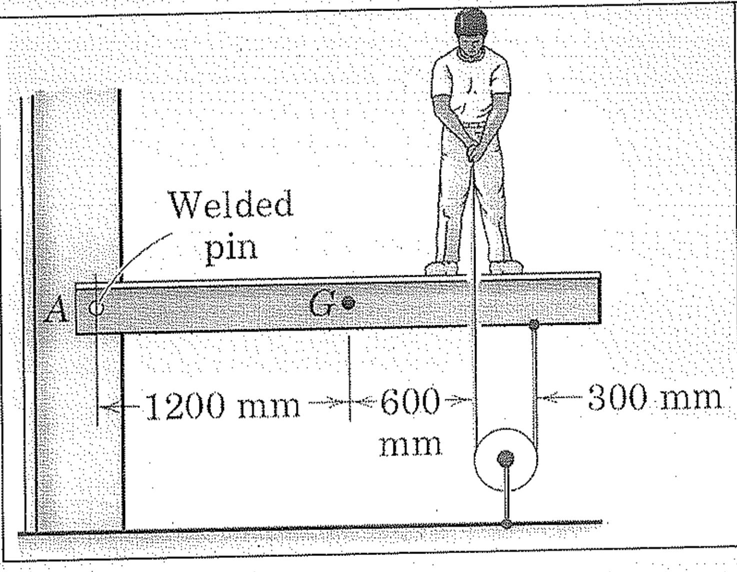
Total moment about shoulder joint is:

$$\sum \vec{M}_{shoulder} = 0$$

$$\Rightarrow F.d_1 - 7 * 9{,}81 * d_2 - G\,(d_2 + d_3) = 0$$

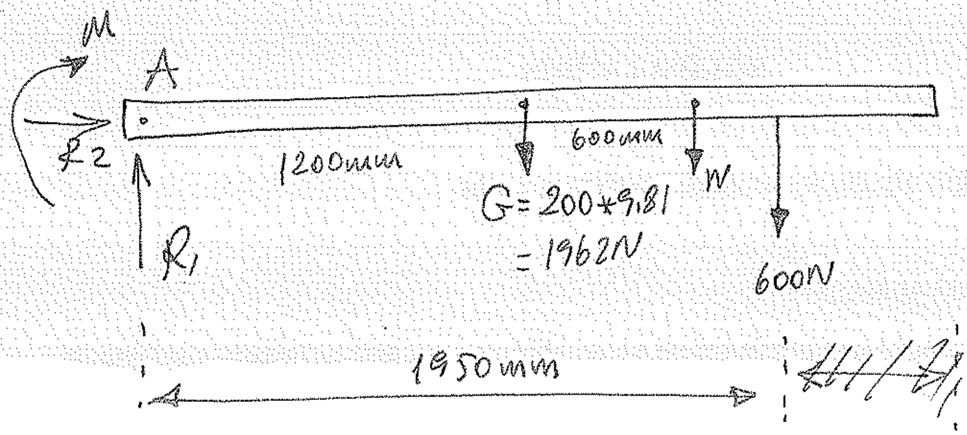
$$600 . 0{,}04 - 13{,}73 - G * 0{,}51 = 0$$

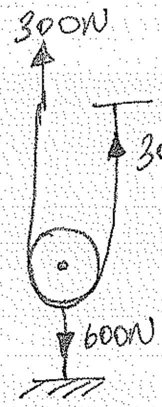
$$\Rightarrow G = 20{,}13\ N$$



The pin A, which connects the 200-kg steel beam with center of gravity at G to the vertical column, is welded both to the beam and to the column. To test the weld, the 80-kg man loads the beam by exerting a 300-N force on the rope which passes through a hole in the beam as shown. Calculate the torque (couple) M supported by the pin. (Ans: M=4,94kNm) (Meriam&Kraige, 2006)

$W = 80 * 9{,}81 = 784{,}8\,N$





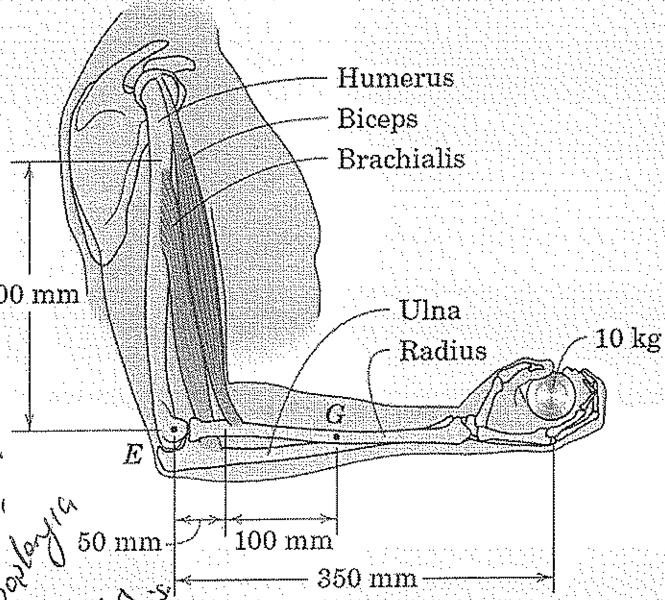
$\sum \vec{F_x} = 0 \Rightarrow R_2 = 0$

$\sum \vec{F_y} = 0 \Rightarrow R_1 - 1962 - 784{,}8 - 600N = 0$

$\Rightarrow R_1 = 3346{,}8\,N$

$\sum \vec{M_z}_A = 0 \Rightarrow -M - 1962 * 1200mm - 784{,}8 * 1800mm - 600N * 1950mm = 0$

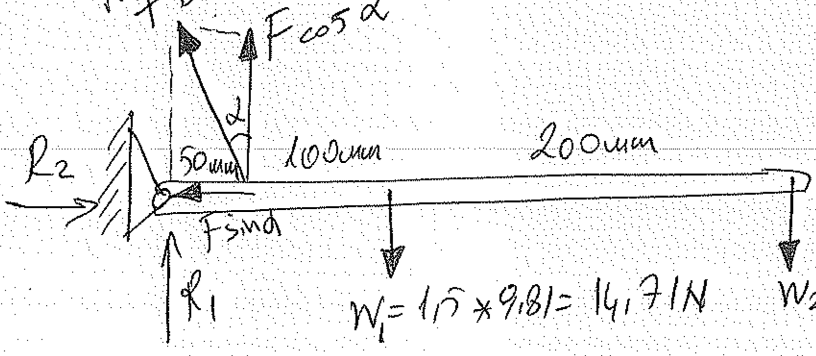
$M \cong 4{,}937N = 4{,}93\,kN$

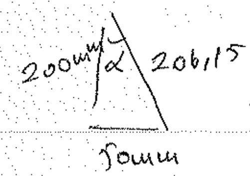


A person is performing slow arm curls with a 10-kg weight as indicated in the figure. The brachialis muscle group (consisting of the biceps and brachialis muscles) is the major factor in this exercise. Determine the magnitude F of the brachialismuscle group force and the magnitude E of the elbow joint reaction at point E for the forearm position shown in the figure. Take the dimensions shown to locate the effective points of application of the two muscle groups; these points are 200 mm directly above E and 50 mm directly to the right of E.Include the effect of the 1.5-kg forearm mass with mass center at point G. State any assumptions. (Ans: F _ 753 N, E _ 644 N)

Dikkat. Burada kas kuvvetinin kol ile yaptığı açı yerine, o bağlayan kasın başlangıç ve bitiş noktalarının koordinatları verilmiş.

F Biceps grup.





$\Rightarrow \sin\alpha = \frac{50}{206{,}15}$

$\cos\alpha = \frac{200}{206{,}15}$

$\sum \vec{F_x} = 0 \Rightarrow R_2 - F\sin\alpha = 0 \Rightarrow R_2 = F.\sin\alpha$

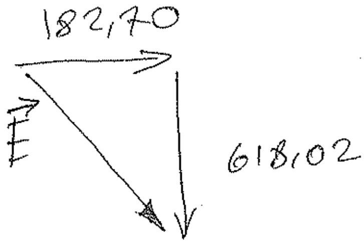
$\sum \vec{F_y} = 0 \Rightarrow F_{\cos\alpha} + R_1 - 14{,}71 - 98{,}1 = 0 \Rightarrow F_{\cos\alpha} + R_1 = 112{,}81\,N$

$\sum M_E = 0 \Rightarrow F_{\cos\alpha} * 50 - 14{,}71 * 150 - 98{,}1 * 350 = 0$

$50 * F_{\cos\alpha} = 2206{,}5 + 34335 \Rightarrow F = 753{,}3\,N$

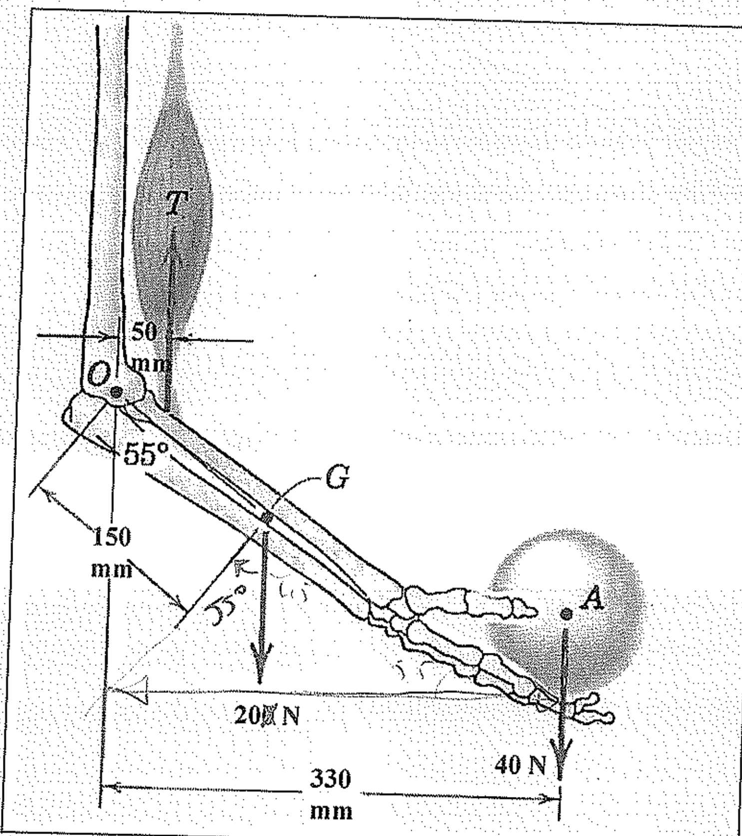
$R_1 = -618{,}02N$

$R_2 = 182{,}70$



$E = \sqrt{R_1^2 + R_2^2} = 644{,}46N$

(Meriam, P:47)



Elements of the lower arm are shown in the figure. The weight of the forearm is 20 N with mass center at G. Determine the combined moment about the elbow pivot O of the weights of the forearm and the sphere. What must the biceps tension force so that the overall moment about O is zero?

$$\sum \vec{M}_o = - G.\cos 55 * 150mm - 40N * 330mm$$

$$\sum \vec{M}_o \approx 15 \ Nm$$

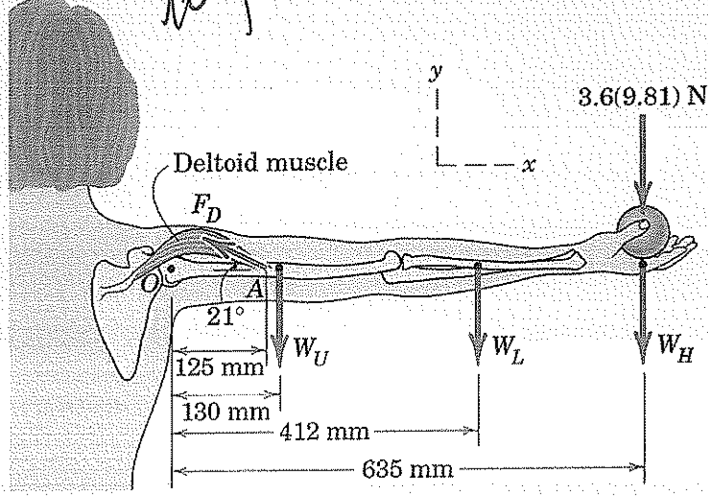
In order to have $\sum \vec{M}_o = 0$

then

$$T * 0{,}05m - 15 Nm = 0$$

$$\Rightarrow T = 300N$$

Question 2 10 puan



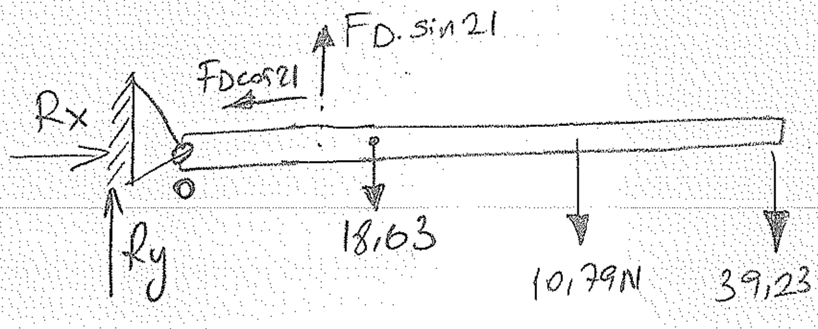
A woman is holding a 3.6-kg sphere in her hand with the entire arm held horizontally as shown in the figure. A tensile force in the deltoid muscle prevents the arm from rotating about the shoulder joint O; this force acts at the angle shown. Determine the force exerted by the deltoid muscle on the upper arm at A and the x- and y-components of the force reaction at the shoulder joint O. The mass of the upper arm is $m_U = 1.9$ kg, the mass of the lower arm is m_L =1.1 kg, and the mass of the hand is m_H=0.4 kg; all the corresponding weights act at the locations shown in the figure.

$W_u = 1,9 * 9,81 = 18,63\,N$

$W_L = 1,1 * 9,81 = 10,79\,N$

$W_H = 0,4 * 9,81 = 3,92\,N$

$W_{sphere} = 3,6 * 9,81 = 35,31\,N$



$\Sigma f_x = 0 \Rightarrow Rx - F_D.\cos 21 = 0$

$\Sigma f_y = 0 \Rightarrow F_D.\sin 21 + Ry - 18,63 - 10,79 - 39,23 = 0$

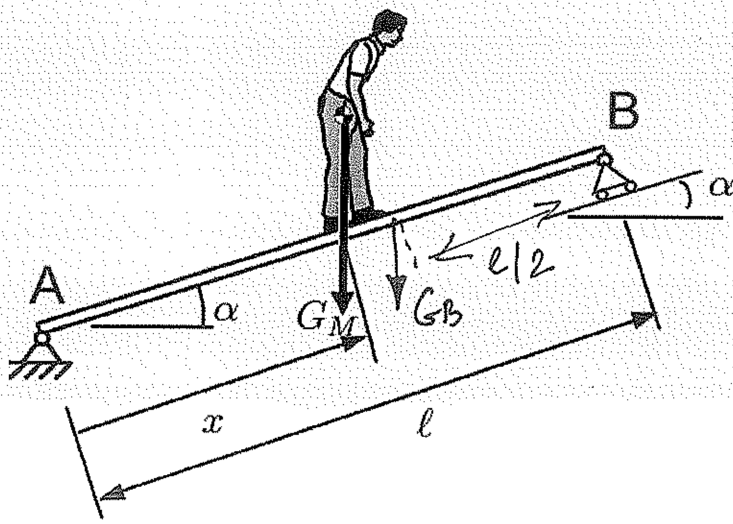
$F_D \sin 21 + Ry = 68,65\,N$

$\Sigma M_o = 0 \Rightarrow F_D.\sin 21 * 125 - \underbrace{18,63 * 130}_{2421,9} - \underbrace{10,79 * 412}_{4445,48} - \underbrace{39,23 * 635}_{24911,05} = 0$

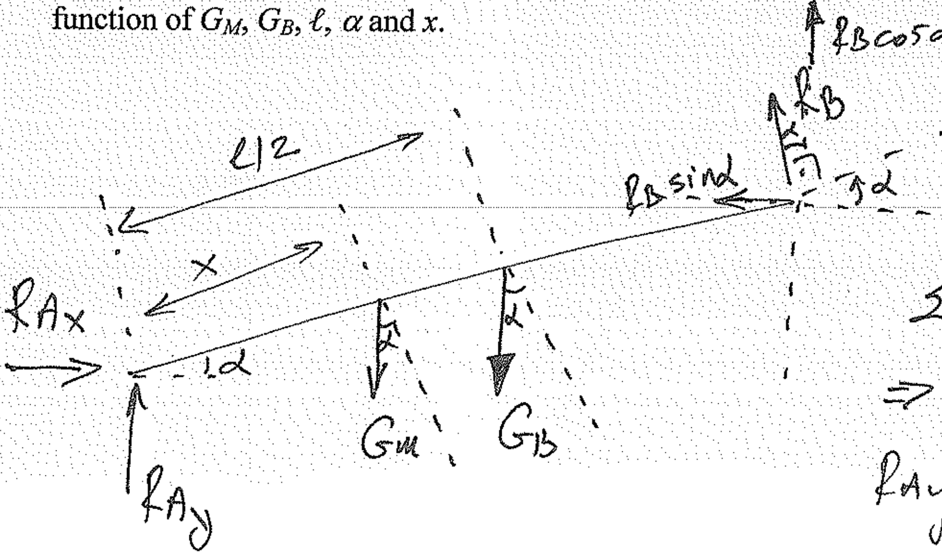
$F_D.\sin 21 = 254,22 \Rightarrow F_D = 710N$ 4 puan

$\Rightarrow Rx = 710.\cos 21 = 662,84\,N$ 3 puan

$\Rightarrow Ry = 68,65 - 710.\sin 21 = -185,79\,N$ 3 puan



A man with weight G_M is walking on a board between the points A and B. The angle between the board and the horizontal plane is α. The weight of the board is G_B, applied in the middle of the board. The distance between point A and the point upon which the weight force G_M acts is x. In point B the board rests on a roll bearing that runs on a support surface, making an angle of α with respect to the horizontal. Determine the reaction forces in points A and B as a function of G_M, G_B, ℓ, α and x.



$\sum \vec{F_x} = 0$

$\Rightarrow R_{Ax} - R_B\sin\alpha = 0$

$\sum \vec{F_y} = 0$

$\Rightarrow R_{Ay} - G_M - G_B + R_B\cos\alpha = 0$

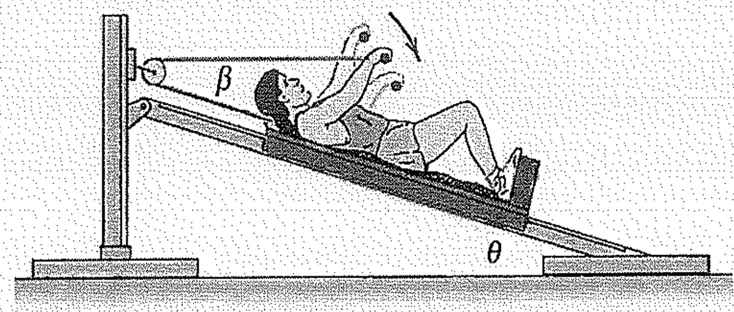
$R_{Ay} + R_B\cos\alpha = G_M + G_B$

$$\sum \vec{M_A} = 0 \Rightarrow -G_M\cos\alpha \cdot x - G_B\cos\alpha \cdot \frac{\ell}{2} + R_B \cdot \ell = 0$$

$$\Rightarrow R_B = \frac{G_M\cos\alpha\, x + G_B\cos\alpha\, \ell/2}{\ell}$$

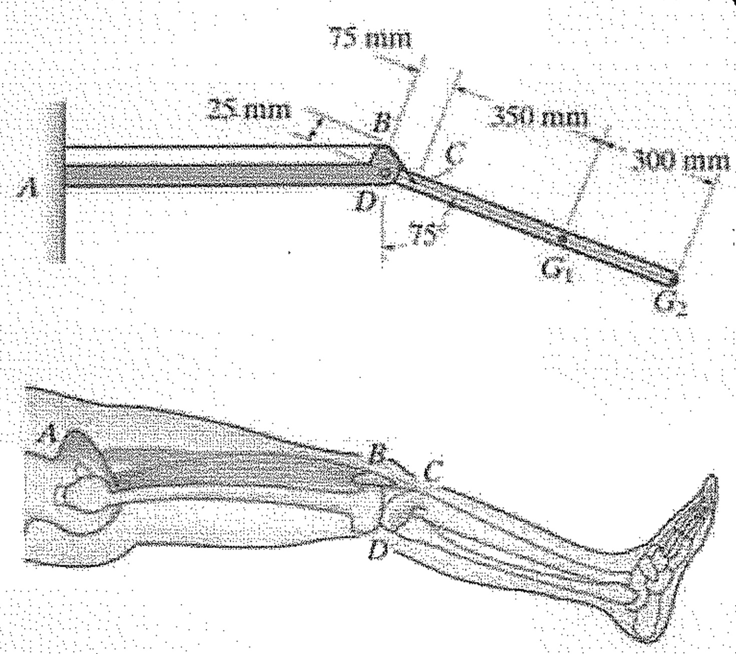
$R_{Ax} = R_B \cdot \sin\alpha$

$R_{Ay} = G_M + G_B - R_B \cdot \cos\alpha$



The exercise is designed with a lightweight cart which is mounted on small rollers so that it is free to move along the inclined ramp. Two cables are attached to the cart-one for each hand. If the hands are together so that the cables are parallel and if each cable lies essentially in a vertical plane, determine the force P which each hand must exert on its cable in order to maintain an equilibrium position. The mass of the person is 70kg, the ramp angle θ is 15°, and the angle β is 18°. In addition, calculate the force R which the ramp exerts on the cart (Ans. P=45.5N; R=691N).

(Hibbeler 5,94)

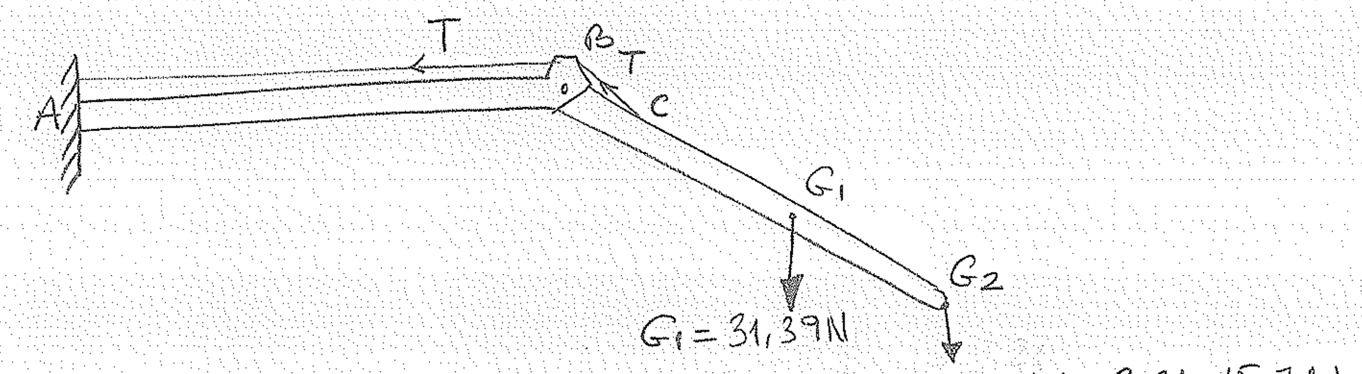


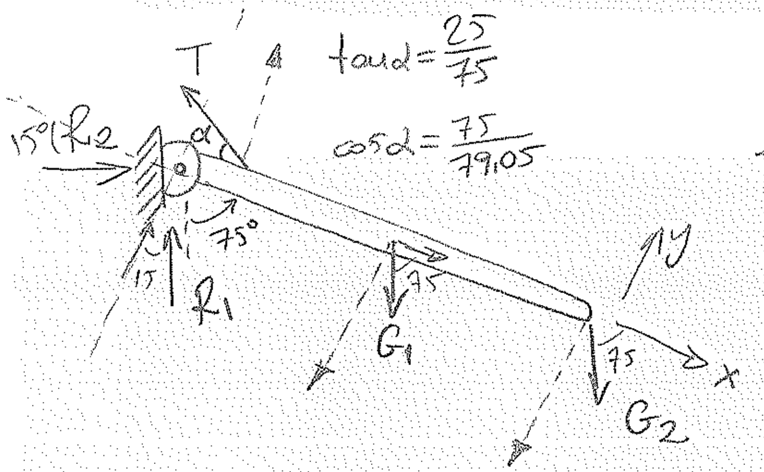
A skeletal diagram of the lower leg is shown in the figure. Here it can be noted that this portion of the led is lifted by the quadriceps muscle attached to the hip at *A* and to the patella bone at *B*. This bone slides freely over cartilage at the knee joint. The quadriceps is further extended and attached to the tibia at *C*. Using the mechanical system shown in the figure to model the lower leg, determine the tension in the quadriceps at *C* and the magnitude of the resultant force at the femur (pin), *D*, in order to hold the lower leg in the position shown. The lower leg has a mass of 3.2 kg and mass center at G_1; the foot has a mass of 1.6 kg and a mass center at G_2. ($T = 1{,}01\,kN$

$D_y = -507{,}66N$

$F_D = 982N$)

Problem: (Hibbeler 5;94)





$\tan\alpha = \frac{25}{75}$

$\cos\alpha = \frac{75}{79,05}$

$\sum \vec{F_x} = 0 \Rightarrow G_1 \cdot \cos 75 + G_2 \cos 75 - T \cdot \cos\alpha - R_1 \cdot \cos 75 + R_2 \cos 15 = 0$

$8,12 + 4,06 - T \cdot \frac{75}{79,05} - 0,25 R_1 + 0,96 R_2 = 0$

$\sum \vec{F_y} = 0 \Rightarrow - G_1 \cdot \sin 75 - G_2 \sin 75 + R_1 \cdot \cos 15 + R_2 \cos 75 + T \cdot \sin\alpha = 0$

$-30,32 - 15,16 + 0,96 R_1 + 0,25 R_2 + T \frac{25}{79,05} = 0$

$\sum M_D = 0 \Rightarrow 75mm * T \cdot \frac{25}{79,05} - 425mm * 30,32 - 725mm * 15,16 = 0$

$23,71\, T = 12886 + 10991 \quad \Rightarrow T = 1007\, N$

$\Rightarrow 0,25 R_1 - 0,96 R_2 = 943,22 \;/\; \frac{0,96}{0,25}$

$\Rightarrow -0,96 R_1 - 0,25 R_2 = 272,98$

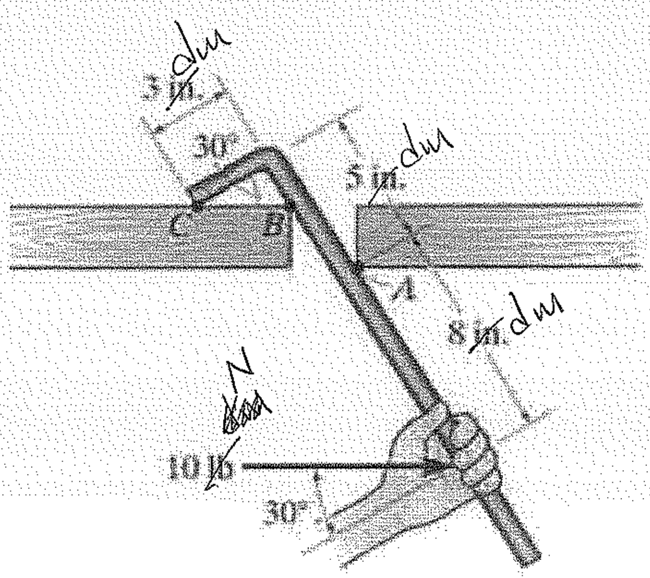
$-3,93 R_2 = 3621,9 \Rightarrow R_2 = -921,6\, N$

$R_1 = 233,93$

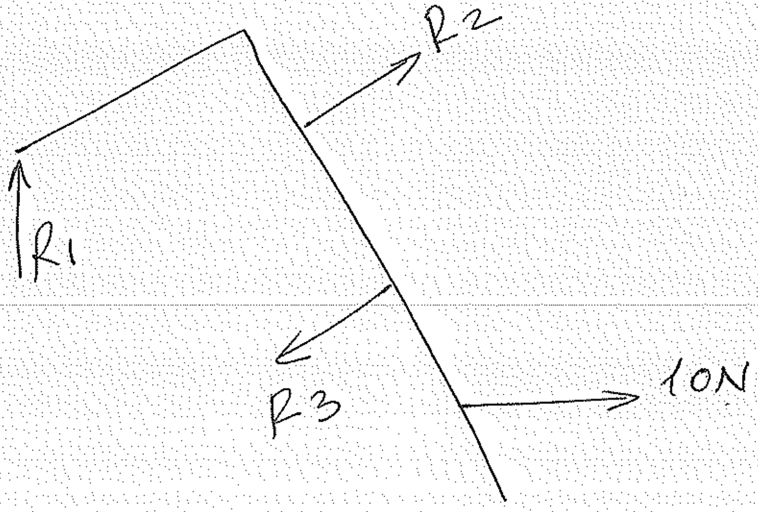
$\Rightarrow$ Resultant Force, $R = \sqrt{R_1^2 + R_2^2}$

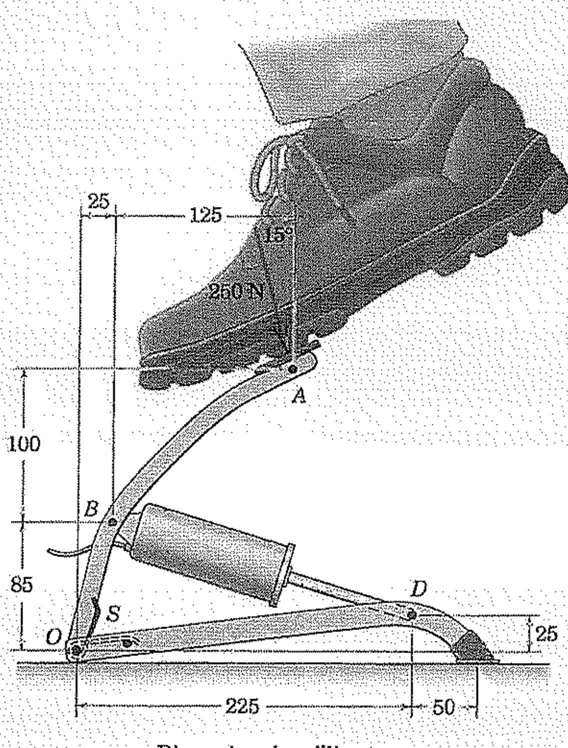
$R = 950N$

(Kitapta 982 N bulunmuş).



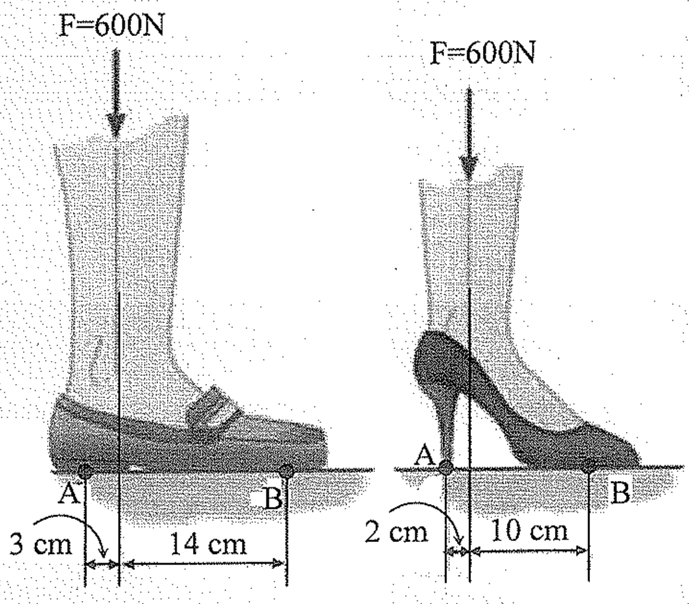
Draw the free-body diagram of the bar, which has a negligible thickness and smooth points of contact at A, B, and C.



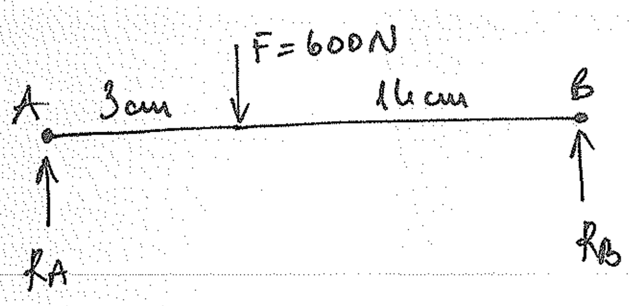


Dimensions in millimeters

A 250 N force is applied to the foot-operated air pump. The return spring S exerts a 3Nm moment on member OBA for this position. Determine the corresponding compression force F_C in the cylinder BD. If the diameter of the piston in the cylinder is 45 mm, estimate the air pressure generated for these conditions. State any assumptions (Ans. $F_C = 510$ N, $p =$ 321 kPa)



Compare the force exerted on the toe and heel of a 600N woman when she is wearing regular shoes and stiletto heels. Assume all her weight is placed on one foot and the reactions occur at points A and B as shown.



$\Rightarrow \quad \sum \vec{F_x} = 0$

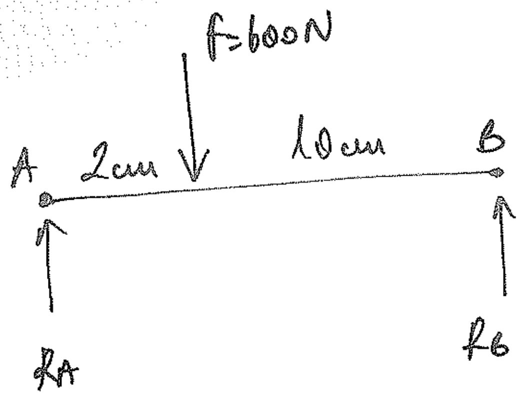
$\sum \vec{F_y} = 0 \Rightarrow R_A - 600 + R_B = 0$

$R_A + R_B = 600N$

$\sum \vec{M_A} = 0 \Rightarrow -600.3 + R_B 17 = 0$

$R_B = 105,88N$

$R_A = 494,22N$



$\sum \vec{F_x} = 0$

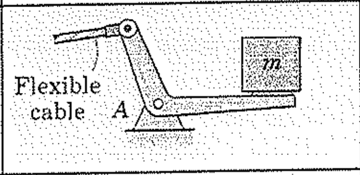
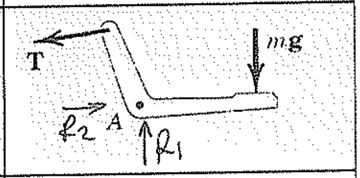
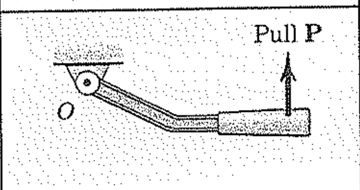
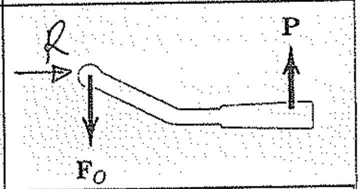
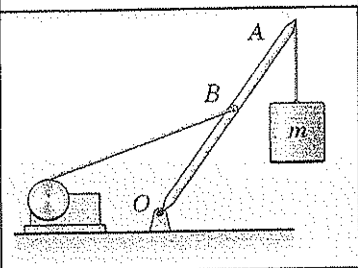
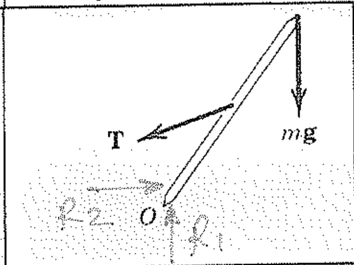
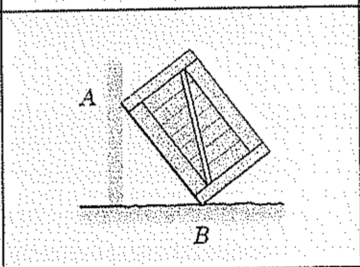
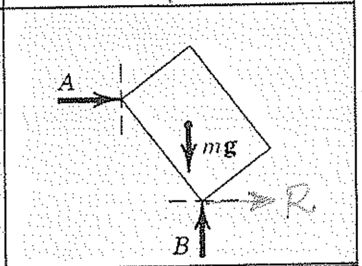
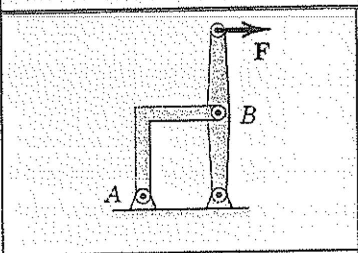
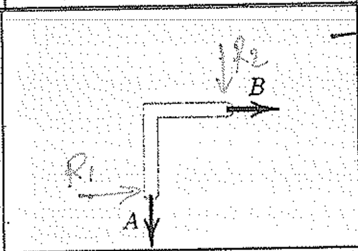
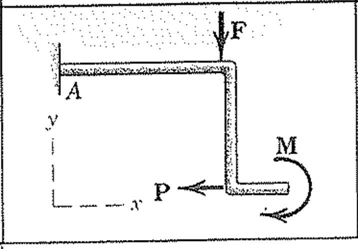
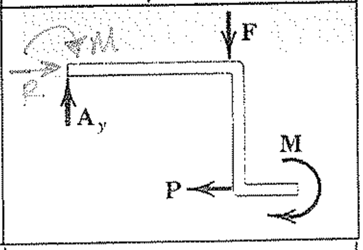
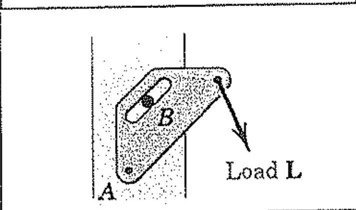
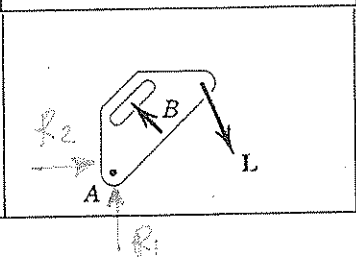
$\sum \vec{F_y} = 0 \Rightarrow R_A + R_B = 600N$

$\sum \vec{M_A} = 0 \Rightarrow -2.600 + 12.R_B = 0$

$R_B = 100N$

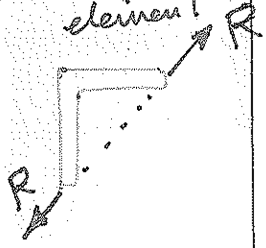
$R_A = 500N$

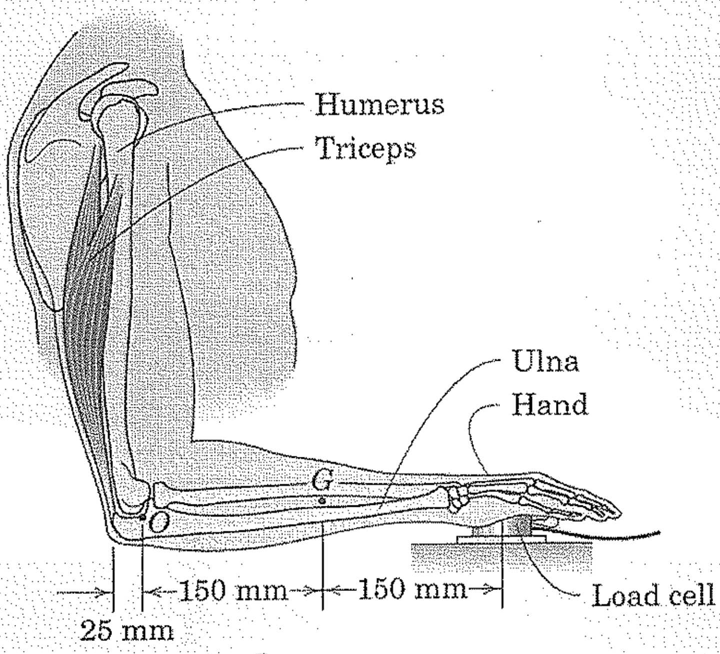
In each of the following examples, the body to be isolated is shown in the left-hand diagram, and an incomplete free-body diagram (FBD) of the isolated body is shown on the right. Add whatever forces are necessary in each case to form a complete free-body diagram. The weights of the bodies are negligible unless otherwise indicated. Dimensions and numerical values are omitted for simplicity (Meriam&Kraige, 2006).

	Body	Incomplete FBD
1. Bell crank supporting mass m with pin support at A.		
2. Control lever applying torque to shaft at O.		
3. Boom OA, of negligible mass compared with mass m. Boom hinged at O and supported by hoisting cable at B.		
4. Uniform crate of mass m leaning against smooth vertical wall and supported on a rough horizontal surface.		
4. Supporting angle bracket for frame; pin joints.		
5. Bent rod welded to support at A and subjected to two forces and couple.		
5. Loaded bracket supported by pin connection at A and fixed pin in smooth slot at B.		

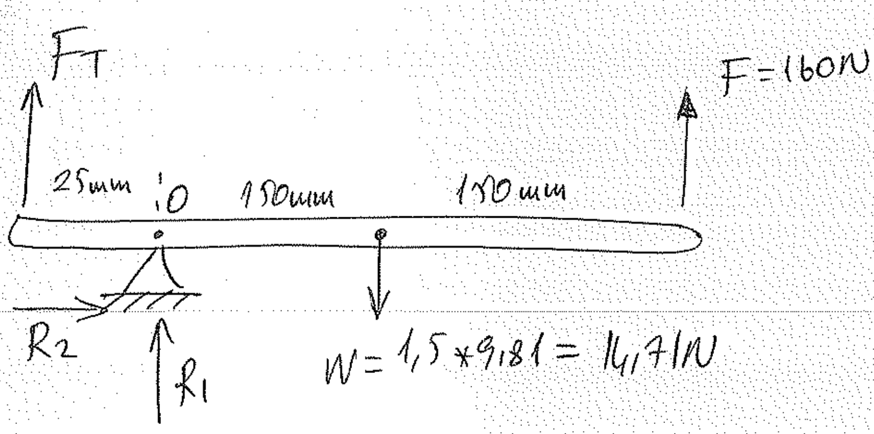
köşebent

Two-force member element





In a procedure to evaluate the strength of the triceps muscle, a person pushes down on a load cell with the palm of his hand as indicated in the figure. If the load-cell reading is 160 N, determine the vertical tensile force F generated by the triceps muscle. The mass of the lower arm is 1.5 kg with mass center at G. State any assumptions. What are the reaction forces of the elbow joint? (Ans: F=1832 N)



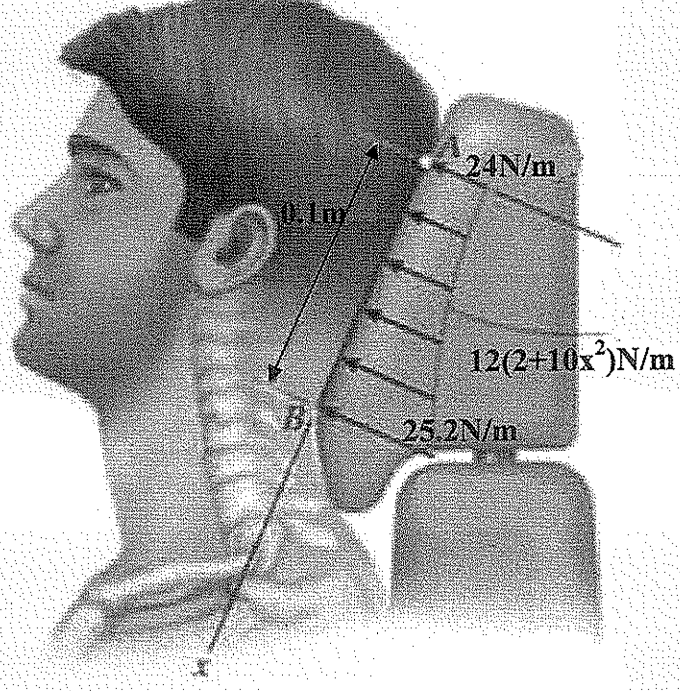
$$\sum \vec{F_x} = 0 \Rightarrow R_2 = 0$$

$$\sum \vec{F_y} = 0 \Rightarrow F_T + R_1 - W + 160N = 0 \Rightarrow R_1 + F_T = -145,29N$$

$$\sum \vec{M_O} = 0 \Rightarrow -F_T \cdot 25 - 14,71 * 150 + 160 * 300 = 0$$

$$F_T\, 25 = -2206,5 + 48000 \Rightarrow F_T = 1831,74N$$

$$R_1 = -1977,3$$



Currently 85% of all neck injuries are caused by rear-end car collisions. To alleviate this problem, an automobile seat restraint has been developed that provides additional pressure contact with the cranium. During dynamic tests the distribution of load on the cranium has been plotted and shown to be parabolic. Determine the equivalent resultant force and its location, measured from point A.

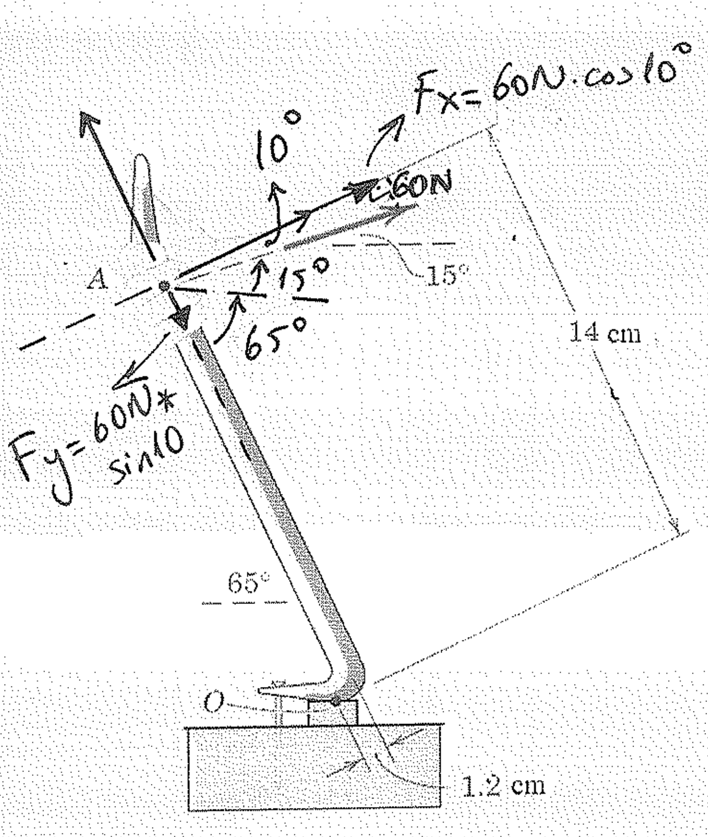
Equivalent Force, $F_R = \int_0^{0,1m} w(x)\,dx = \int_0^{0.1m} 12.(2+10x^2)\,dx$

$F_R = (24x + 40x^3)\Big|_0^{0.1} = 2,44\,N$

Location of the equivalent force

$$\bar{X} = \frac{\int w(x).x\,dx}{\int w(x)\,dx} = \frac{\int_0^{0.1} 12x(2+10x^2)\,dx}{2,44\,N} = \frac{(12x^2 + 30x^4)\Big|_0^{0.1}}{2,44\,N}$$

$\bar{X} = 0,0504\,m.$

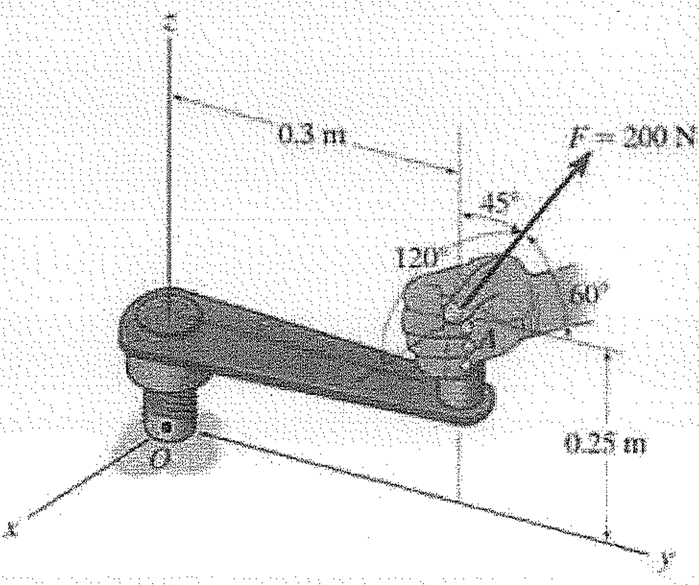


(Meriam and Kraige, Statics)

10. A prybar is used to remove a nail as shown. Determine the moment of the 60N force about the point O of contact between the prybar and the small support block.

$$\Sigma M_O = -60N \cdot \cos 10 \cdot 14\,cm - 60N \sin 10 \cdot 1{,}2\,cm$$

$$\Sigma M_O = -839{,}74\ Ncm.$$



Determine the magnitude of the moment of the 200-N force about the *x* axis.

Force vector

$\vec{F} = \{200 \cos 120 \vec{i} +$
$200 . \cos 60 \vec{j} + 200 \cos 45 \vec{k}\} N$

$\vec{r} = \{0 \vec{i} + 0{,}3 \vec{j} + 0{,}25 \vec{k}\} N$

$\Rightarrow \vec{M} = \vec{r} \times \vec{F} = (0{,}3 \vec{j} + 0{,}25 \vec{k}) \times (-100 \vec{i} + 100 \vec{j} + 141{,}42 \vec{k})$

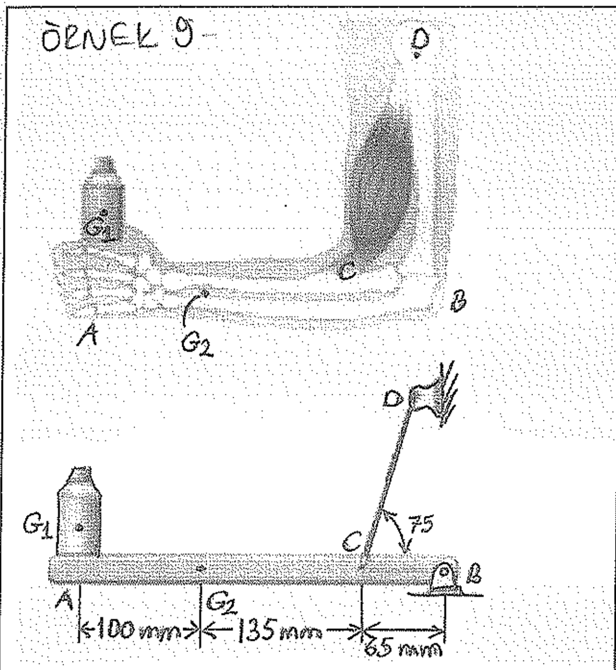
$\vec{M} = +30 \vec{k} + 42{,}42 \vec{i} - 25 \vec{j} - 25 \vec{i}$

$\vec{M} = 17{,}42 \vec{i} - 25 \vec{j} + 30 \vec{k}$

moment component around x axis

moment component around y axis.

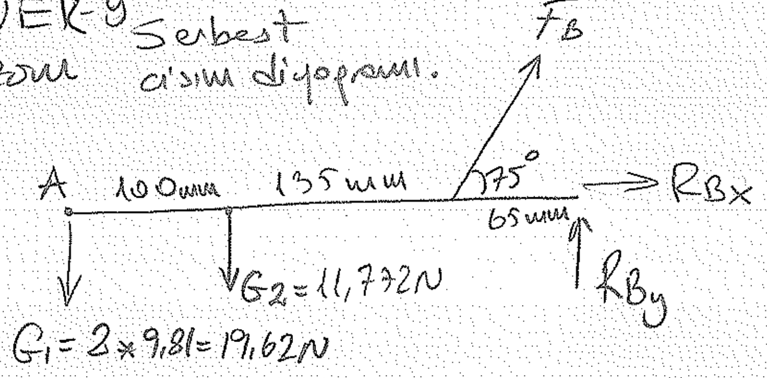
moment components around z axis.

	**SORU 6.** Yük ve ön kolun kütleleri sırasıyla 2 kg ve 1.2 kg'dır ve ağırlık merkezleri G_1 ve G_2 ile gösterilmektedir. Biceps kasının uyguladığı kuvvet ile B noktasındaki reaksiyon kuvvetinin yatay ve düşey eksenlerdeki bileşenlerini hesaplayınız. (Not: Kas iskelet sistemi statik denge halindedir).

ÖRNEK-9

ÇÖZÜM

Serbest cisim diyagramı.



Statik denge şartları.

$$\Sigma F_x = 0 \Rightarrow F_B . \cos 75 + R_{Bx} = 0$$

$$\Sigma F_y = 0 \Rightarrow -G_1 - G_2 + F_B . \sin 75 + R_{By} = 0$$

$$-19,62 - 11,772 + 0,965 F_B + R_{By} = 0$$

$$0,965 F_B + R_{By} = 31,392 N$$

$$\Sigma M_A = 0 \Rightarrow -11,772 * 100mm + F_B . \sin 75 * 235mm + R_{By} . 300mm = 0$$

$$226,99 F_B + 300 R_{By} = 1177,2$$

$$-300 / 0,965 F_B + R_{By} = 31,392$$

$$226,99 F_B + 300 R_{By} = 1177,2$$

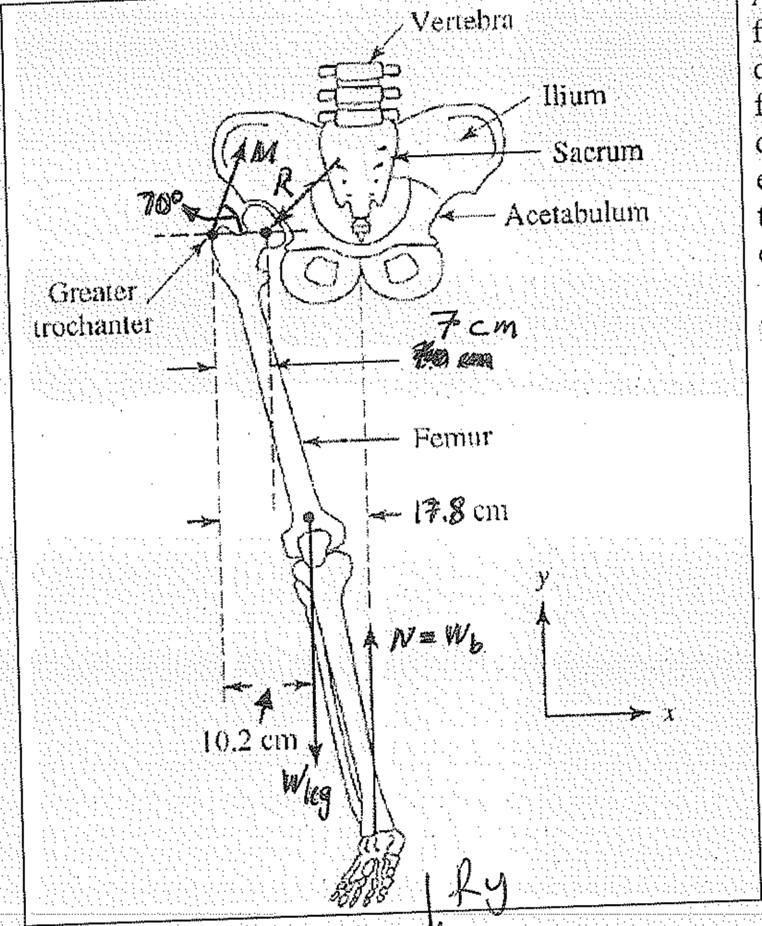
$$-289,5 F_B - 300 R_{By} = -9417,6$$

$$-62,51 F_B = -8240,4 \Rightarrow F_B = 131,8 N$$

$$\Rightarrow R_{By} = -95,81 N$$

$$R_{Bx} = -34,11 N.$$

with mass 90kp



Anatomical diagram of the leg and hip for someone standing on one leg, or during slow walking, showing the forces on them and relevant dimensions, including the force exerted on the head of the femur by the acetabulum ***R*** and the net force exerted by the hip abductor muscles. W_{leg} is the weight of the leg and equals to $0.16W_b$. It acts as if it were applied at the center of mass of the leg, which is approximately halfway down the leg. ***R*** is the reaction force on the leg from the hip, and it is normal to the hip socket. ***M*** is the force due to the hip abductor muscles. There are actually three muscles involved here: the tensor fascia latae, gluteus minimus, and the gluteus medius (the gluteus maximus muscle is what I am sitting on as I am typing this). The hip abductor muscle structure we consider is a composite of the three muscles. Determine the forces ***R***, ***M***, W_b, W_{leg}.

F.B.D

$\sum \vec{F_x} = 0 \Rightarrow M\cos 70 - R_x = 0$

$\sum \vec{F_y} = 0 \Rightarrow M\sin 70 - R_y + W_{leg} - W_b = 0$

$\sum \vec{M}_{\text{Great trochanter}} = 0 \Rightarrow -R_y * 7cm - W_{leg} * 10.2cm + W_b * 17{,}8cm = 0$

$W_{leg} = 0.016 W_b$

m = 90 kp

$\Rightarrow W_b = 882{,}9N$

$R_x = 0{,}342M$

$R_y = 0{,}939M$

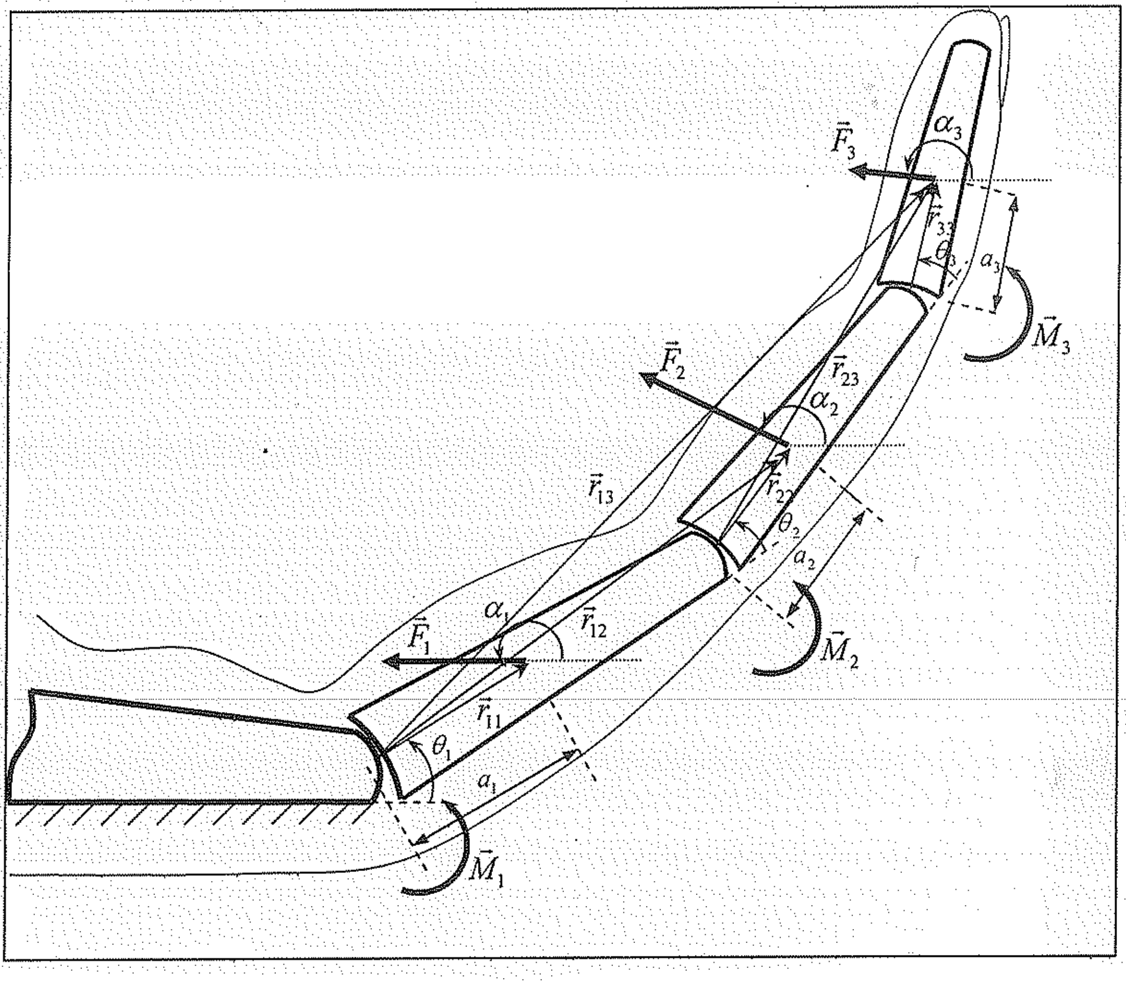
(1) $0{,}342 M - R_x = 0$

(2) $0{,}939 M - R_y + 0.016W_b - W_b = 0$

(3) $-R_y * 7cm - 0.016W_b * 10.2cm + W_b * 17{,}8cm = 0$

ÖRNEK 7 ÇÖZÜM

ÖRNEK: Şekildeki işaret parmağının phalange kemikleri, $\vec{F}_1$, $\vec{F}_2$ ve $\vec{F}_3$ tendon kuvvetleri altında fleksiyon hareketi yapmaktadır. Bu esnada parmak eklemlerinde oluşan $\vec{M}_1$, $\vec{M}_2$ ve $\vec{M}_3$ momentlerini bulunuz. Proximal, middle ve distal phalange'ın uzunlukları sırasıyla l_1, l_2 ve l_3 tür.



$$\vec{M}_3 = \vec{r}_{33} \times \vec{F}_3$$

$$\vec{M}_2 = \vec{r}_{22} \times \vec{F}_2 + \vec{r}_{23} \times \vec{F}_3$$

$$\vec{M}_1 = \vec{r}_{11} \times \vec{F}_1 + \vec{r}_{12} \times \vec{F}_2 + \vec{r}_{13} \times \vec{F}_3$$

$$\overrightarrow{M_3} = a_3\{\cos(\theta_1+\theta_2+\theta_3)\vec{i} + \sin(\theta_1+\theta_2+\theta_3)\vec{j}\} \times$$
$$F_3.\{\cos\alpha_3\vec{i} + \sin\alpha_3\vec{j}\}$$

$$\overrightarrow{M_3} = a_3.F_3.\{\cos\theta_{123}\sin\alpha_3\vec{k} - \sin\theta_{123}.\cos\alpha_3\vec{k}\}$$

$$\Rightarrow M_3 = a_3F_3(\cos\theta_{123}\sin\alpha_3 - \sin\theta_{123}\cos\alpha_3)$$

$$M_3 = a_3.F_3.\sin(\alpha_3-\theta_{123})$$

$$\overrightarrow{M_2} = (a_2\cos\theta_{12}\vec{i} + a_2\sin\theta_{12}\vec{j}) \times (F_2.\cos\alpha_2\vec{i} +$$
$$F_2\sin\alpha_2\vec{j}) + (l_2\cos\theta_{12}\vec{i} + a_3\cos\theta_{123}\vec{i} + l_2\sin\theta_{12}\vec{j}$$
$$a_3\sin\theta_{123}\vec{j}) \times F_3(\cos\alpha_3\vec{i} + \sin\alpha_3\vec{j})$$

$$\overrightarrow{M_2} = a_2\cos\theta_{12}.F_2.\sin\alpha_2\vec{k} - a_2F_2.\sin\theta_{12}\cos\alpha_2\vec{k}$$
$$- l_2\sin\theta_{12}F_3\cos\alpha_3\vec{k} - a_3\sin\theta_{123}F_3\cos\alpha_3\vec{k} +$$
$$l_2\cos\theta_{12}F_3\sin\alpha_3\vec{k} + a_3\cos\theta_{123}F_3\sin\alpha_3\vec{k}$$

$$\overrightarrow{M_2} = a_2F_2\sin(\alpha_2-\theta_{12})\vec{k} + F_3l_2\sin(\alpha_3-\theta_{12})\vec{k}$$
$$+ a_3.F_3\sin(\alpha_3-\theta_{123})\vec{k}$$

$$M_2 = a_2F_2\sin(\alpha_2-\theta_{12}) + l_2F_3\sin(\alpha_3-\theta_{12})$$
$$+ a_3F_3\sin(\alpha_3-\theta_{123})$$

$$\vec{M_1} = (a_1 \cos\theta_1 \vec{i} + a_1 \sin\theta_1 \vec{j}) \times (F_1 \cos\alpha_1 \vec{i} + F_1 \sin\alpha_1 \vec{j}) +$$

$$(l_1 \cos\theta_1 \vec{i} + a_2 \cos\theta_{12} \vec{i} + l_1 \sin\theta_1 \vec{j} + a_2 \sin\theta_{12} \vec{j}) \times$$

$$(F_2 \cos\alpha_2 \vec{i} + F_2 \sin\alpha_2 \vec{j}) + (l_1 \cos\theta_1 \vec{i} + l_2 \cos\theta_{12} \vec{i} +$$

$$a_3 \cos\theta_{123} \vec{i} + l_1 \sin\theta_1 \vec{j} + l_2 \sin\theta_{12} \vec{j} + a_3 \sin\theta_{123} \vec{j}) \times$$

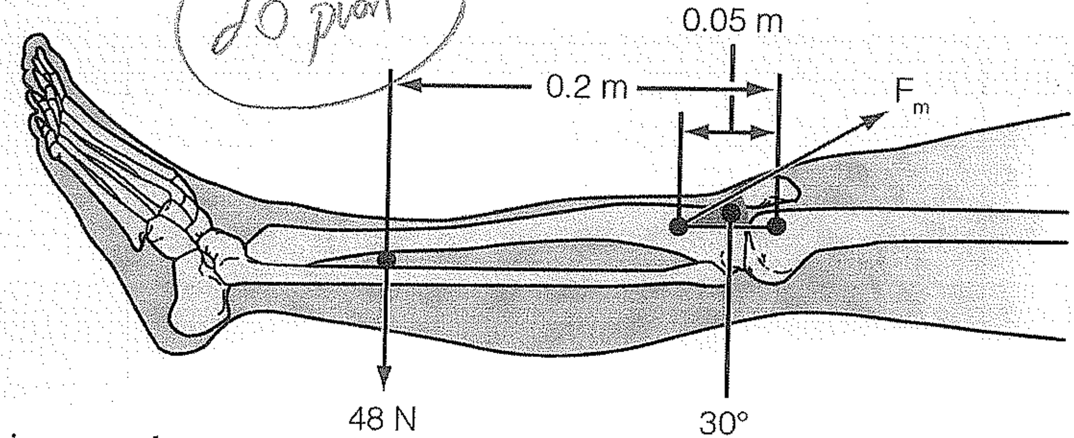
$$(F_3 \cos\alpha_3 \vec{i} + F_3 \sin\alpha_3 \vec{j})$$

$$\vec{M_1} = a_1 F_1 \cos\theta_1 \sin\alpha_1 \vec{k} - a_1 F_1 \sin\theta_1 \cos\alpha_1 \vec{k} +$$
$$l_1 F_2 \sin\alpha_2 \cos\theta_1 \vec{k} + a_2 F_2 \cos\theta_{12} \sin\alpha_2 \vec{k} +$$
$$- l_1 F_2 \sin\theta_1 \cos\alpha_2 \vec{k} - a_2 F_2 \sin\theta_{12} \cos\alpha_2 \vec{k} +$$
$$l_1 F_3 \cos\theta_1 \sin\alpha_3 \vec{k} + l_2 F_3 \cos\theta_{12} \sin\alpha_3 \vec{k} +$$
$$a_3 F_3 \cos\theta_{123} \sin\alpha_3 \vec{k} - l_1 F_3 \sin\theta_1 \cos\alpha_3 \vec{k} +$$
$$- l_2 F_3 \sin\theta_{12} \cos\alpha_3 \vec{k} - a_3 F_3 \sin\theta_{123} \cos\alpha_3 \vec{k}$$

$$\vec{M_1} = a_1 F_1 \sin(\alpha_1 - \theta_1) \vec{k} + F_2 l_1 \sin(\alpha_2 - \theta_1) \vec{k} +$$
$$+ a_2 F_2 \sin(\alpha_2 - \theta_{12}) \vec{k} + l_1 F_3 \sin(\alpha_3 - \theta_1) \vec{k} +$$
$$l_2 F_3 \sin(\alpha_3 - \theta_{12}) \vec{k} + a_3 F_3 \sin(\alpha_3 - \theta_{123}) \vec{k}$$

$$M_1 = a_1 F_1 \sin(\alpha_1 - \theta_1) + F_2 l_1 \sin(\alpha_2 - \theta_1) + a_2 F_2 \sin(\alpha_2 - \theta_{12})$$
$$+ l_1 F_3 \sin(\alpha_3 - \theta_1) + l_2 F_3 \sin(\alpha_3 - \theta_{12}) + a_3 F_3 \sin(\alpha_3 - \theta_{123})$$

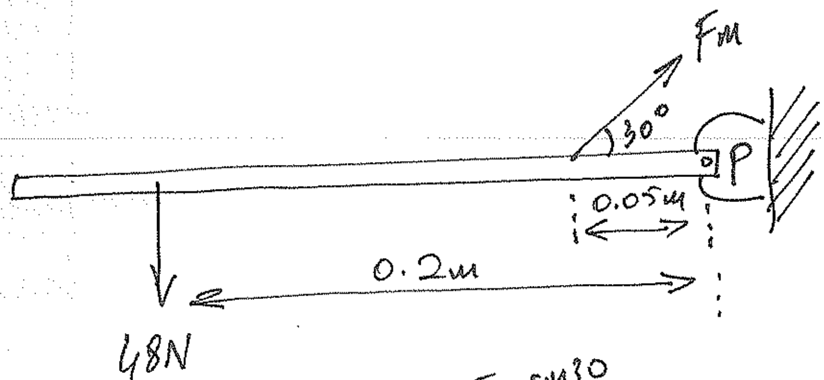
20 puan

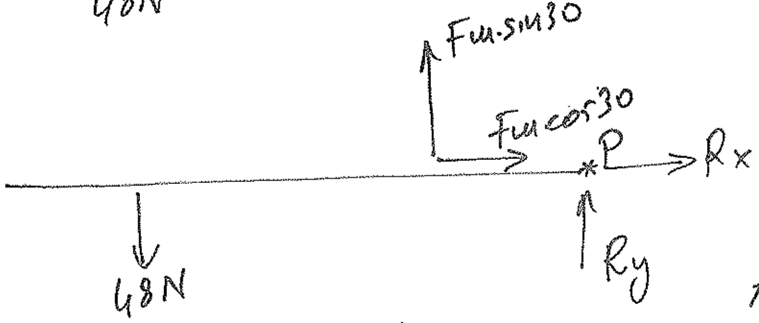


Quadriceps muscles are contracting to hold the lower leg in static equilibrium. Tibia is pulled into the femur by the muscle contraction; the femur will exert a reaction force on the tibia. The quadriceps tendon is inserted on the tibia, approximately 5 cm from the axis of rotation of the knee joint, and the force vector (F_m) representing quadriceps force is oriented at approximately 30°. The weight of the lower leg of an 80-kg male is approximately 48 N. If the person is 1.78 m in height, then the center of gravity of the lower leg is approximately 0.20 m from the knee joint. Find the quadriceps (F_m) and knee joint reactions forces. In addition, find the magnitude and orientation of the reaction force of the femur.

$F_m = ?$

$R = ?$





$\sum \vec{F_x} = 0$

$\Rightarrow F_m \cos 30 + R_x = 0$

$\sum \vec{F_y} = 0$

$F_m \sin 30 - 48 + R_y = 0$

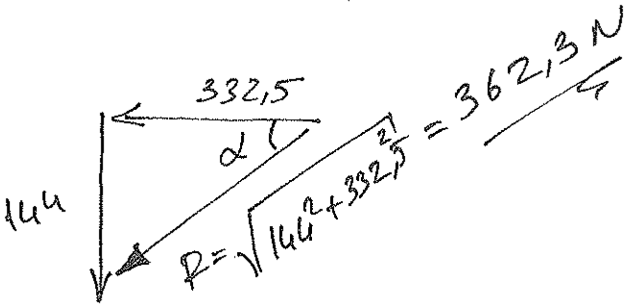
$\sum \vec{M_P} = 0$

$48 * 0{,}2 - F_m \sin 30 * 0.05 = 0$

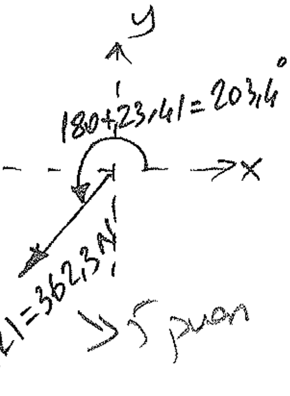
$\Rightarrow F_m = 384\,N \Rightarrow 5$ puan

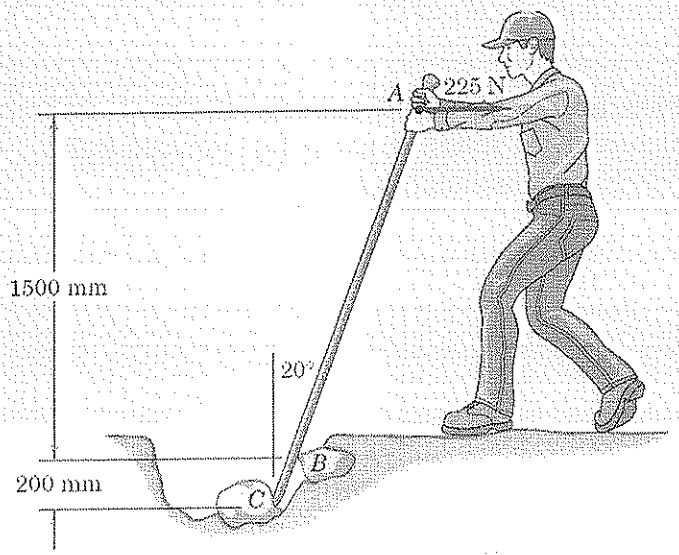
$R_x = -332{,}5\,N \Rightarrow 5$ puan

$R_y = -144\,N \Rightarrow 5$ puan



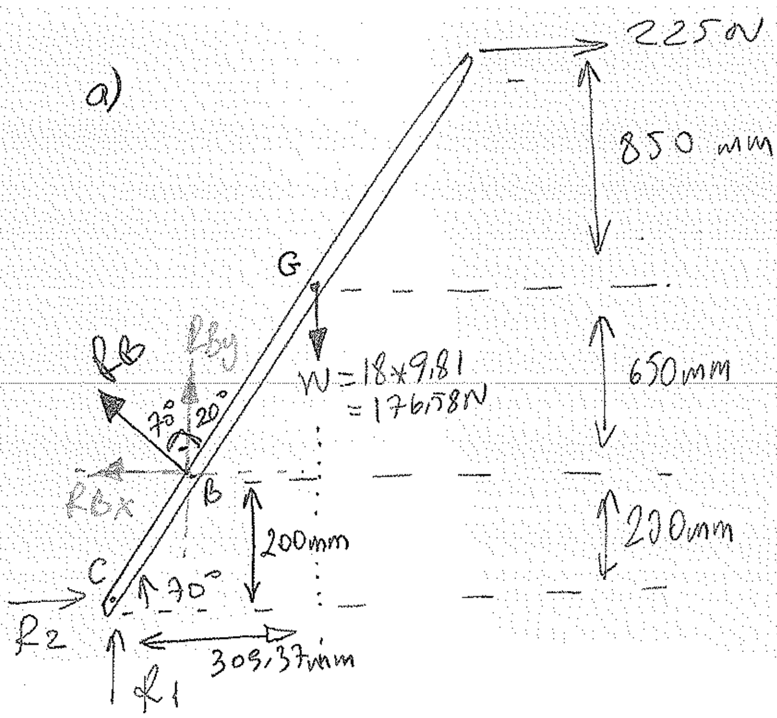
$\alpha = \text{Arctan}\,\frac{144}{332{,}5} \Rightarrow \alpha = 23{,}41$





While digging a small hole prior to planting a tree, a homeowner encounters rocks. If he exerts a horizontal 225N force on the prybar as shown, what is the horizontal force exerted on rock C? Note that a small ledge on rock C supports a vertical force reaction there. Neglect friction at B. Complete solutions (a) including and (b) excluding the weight of the uniform 18-kg prybar.

a)



$\sum \vec{F_x} = 0$

$225 - R_{Bx} + R_2 = 0$

$R_2 = R_{Bx} - 225$

$\sum \vec{M_c} = 0$

$-225 * 1700 + R_B * 212,83 - W * 309,37 = 0$

$\Rightarrow R_B = 2061,92\ N$

$\Rightarrow R_{Bx} = 1937,57\ N$

$\Rightarrow R_2 = 1937,57 - 225$

$R_2 \cong 1712\ N$ 9 puan

$|CB| = \frac{200}{\sin 70} = 212,83\ mm$

$|CG| = \frac{850}{\sin 70} = 904,55\ mm$

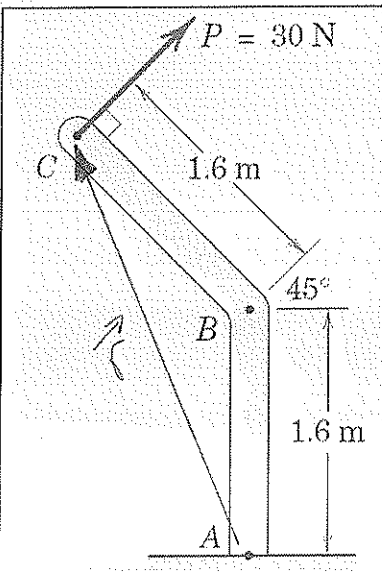
b) Excluding the weight of the prybar.

$\sum \vec{F_x} = 0 \Rightarrow 225 - R_{Bx} + R_2 = 0 \Rightarrow R_2 = R_{Bx} - 225$

$\sum \vec{M_c} = 0 \Rightarrow -225 * 1700 + R_B * 212,83 = 0 \Rightarrow R_B = 1797,2N$

$\Rightarrow R_{Bx} = 1688,8N$

$\Rightarrow R_2 = 1688,8 - 225 = 1463,8\ N$ 5 puan



$\vec{P} = P_x \vec{i} + P_y \vec{j}$

$P_x = P \cdot \cos 45$

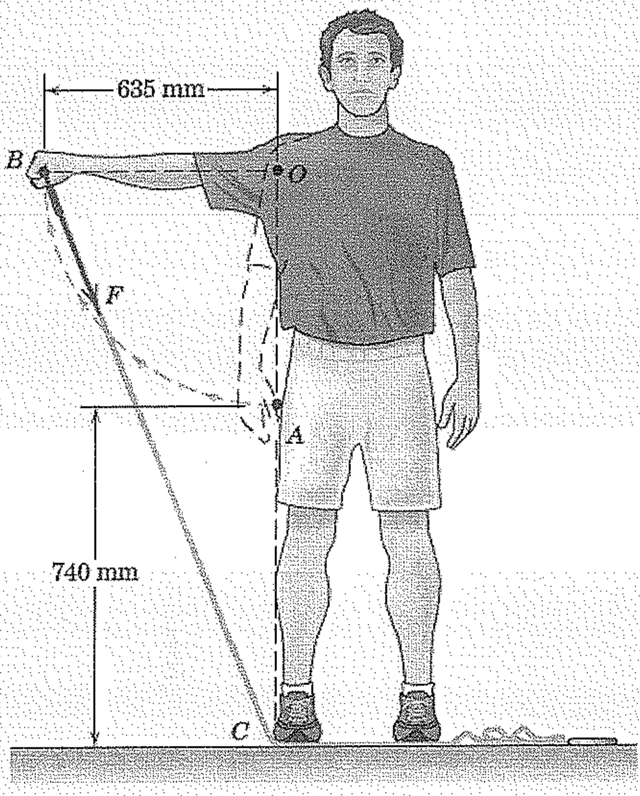
$P_y = P \cdot \sin 45$

The 30N force **P** is applied perpendicular to the portion *BC* of the bent bar. Determine the moment of **P** about point *B* and about point *A*. Meriam and Craige, Ans: Mb 48 Nm Ma: 81.9 Nm

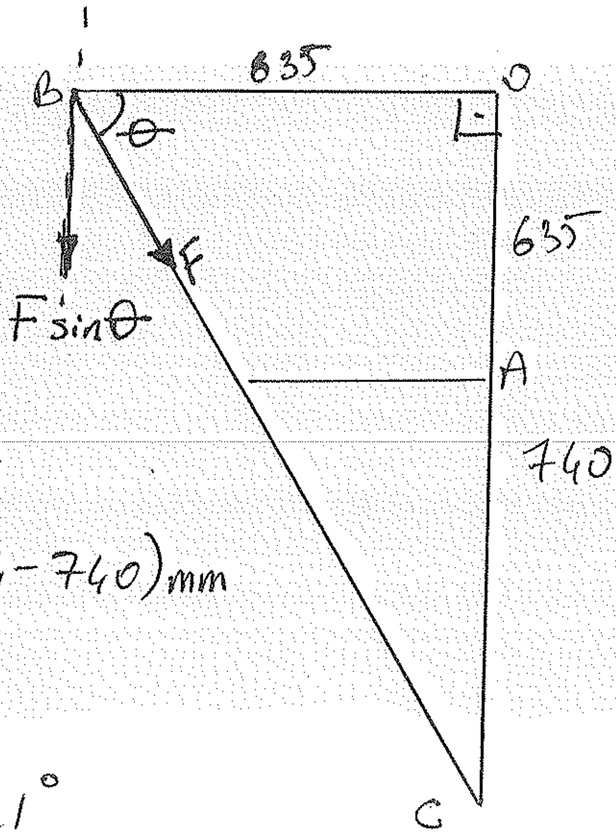
$\Sigma M_B = -30N * 1{,}6m = 48Nm$

$\Sigma \vec{M_A} = \vec{r} \times \vec{P} = (-1{,}13\vec{i} + 2{,}73\vec{j}) \times (21{,}21\vec{i} + 21{,}21\vec{j})$

$\Sigma \vec{M_A} = -23{,}96\vec{k} - 57{,}90\vec{k} = -81{,}86\vec{k}$ Nm



An exerciser begins with his arm in the relaxed vertical position *OA*, at which the elastic band is outstretched. He then rotates his arm to the horizontal position *OB*. The elastic modulus (stiffness) of the hand is k = 60N/m; that is, 60 N of force is required to stretcht the band each additional meter of elongation. Determine the moment about *O* of the force which the band exerts on the hand *B* (Ans: 26.8 Nm).



$$BC^2 = 635^2 + 1375^2$$

$$BC = 1514,54 \text{ mm}$$

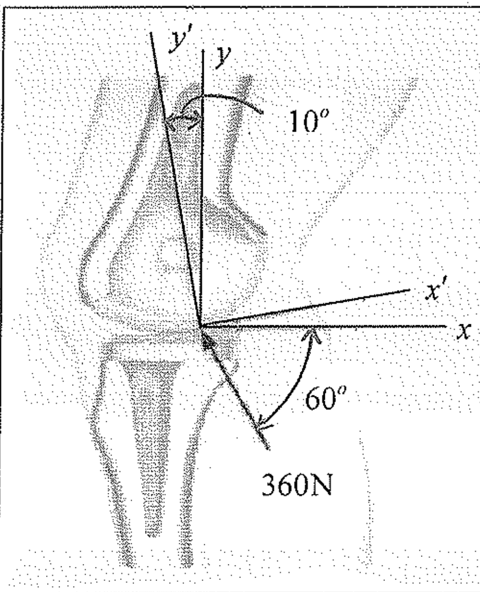
$$\Rightarrow F = k \cdot \Delta x = 60 \frac{N}{m} * (1514,54 - 740) mm$$

$$F = 46,47 N$$

$$\tan\theta = \frac{1375}{635} \Rightarrow \theta = 65,21°$$

$$\Rightarrow M_o = F . \sin\theta . 635 mm$$

$$M_o = 46,47 . \sin(65,21) . 0,635 m = 26,78 Nm$$

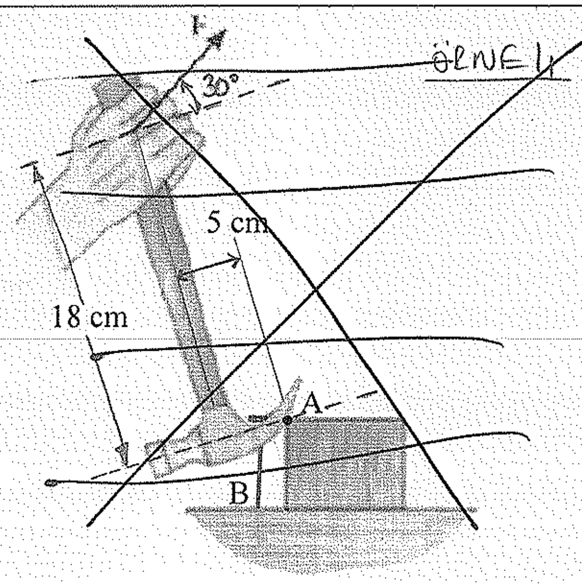


SORU 1. Şekildeki diz protezine gelen kuvvet 360 N'dur. Bu kuvvetin x' ve y eksenlerindeki bileşke kuvvetlerini hesaplayınız.

$x' \rightarrow F_{x'} = 123,12N$

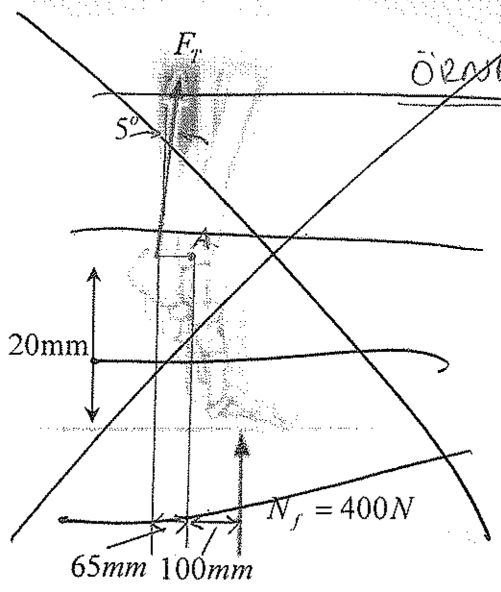
$y \rightarrow F_y = 311,76N.$

ÖRNEK 4



~~**SORU 2.** B'deki çiviyi çıkarabilmek için elin A noktası çevresinde saat yönün ~~tersinde~~ de uygulaması gereken moment değeri 500 Ncm'dir. F kuvvetinin değerini hesaplayınız.~~

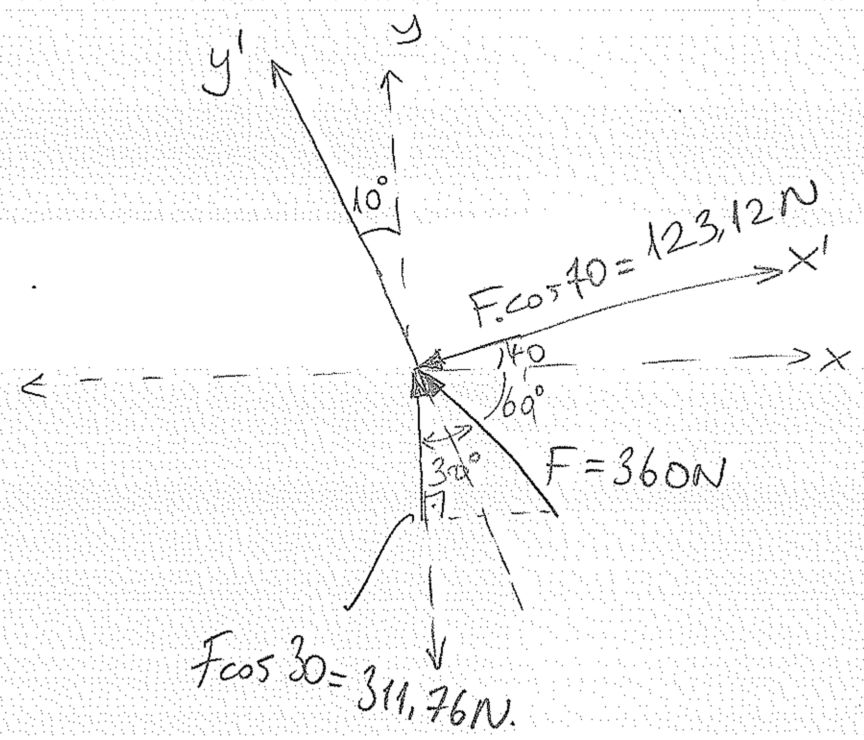
ÖRNEK 5



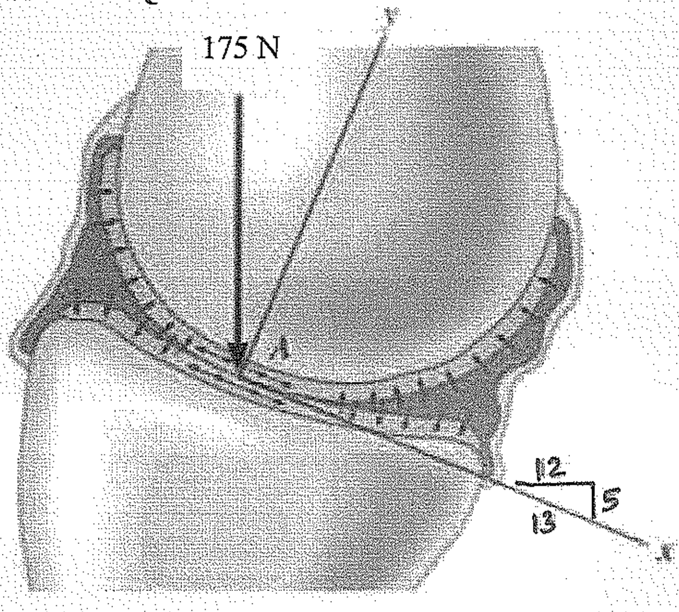
~~**SORU 3.** Şekildeki insan vücudu ayak ucunun üzerinde doğrulduğu zaman Achilles tendonunun üzerinde şekildeki gibi bir F_T kuvveti oluşmaktadır. Bu sırada 400 N'luk bir tepki kuvveti N_f ortaya çıkmaktadır. Eğer F_T ve N_f kuvvetlerinin bilekte (A noktası) oluşturdukları moment sıfıra eşitse F_T kuvvetini hesaplayınız.~~

ÖRNEK

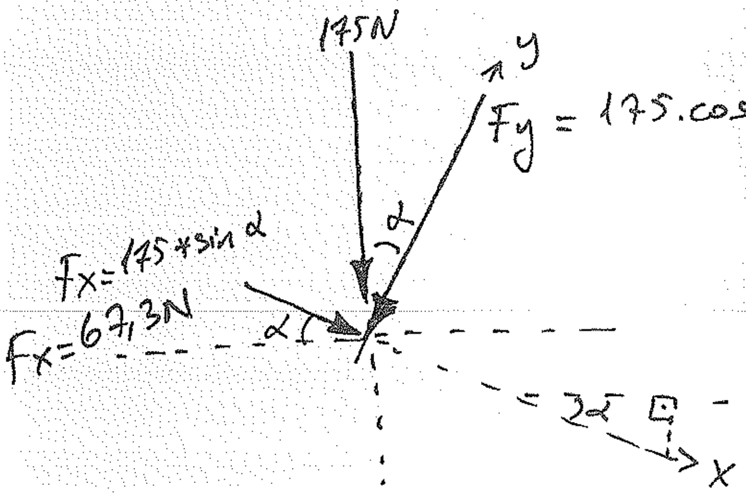
Diz protezine gelen kuvvet 360N'dur. X' ve Y eksenlerindeki bileşkesini hesaplayınız.



STATIC QUESTIONS



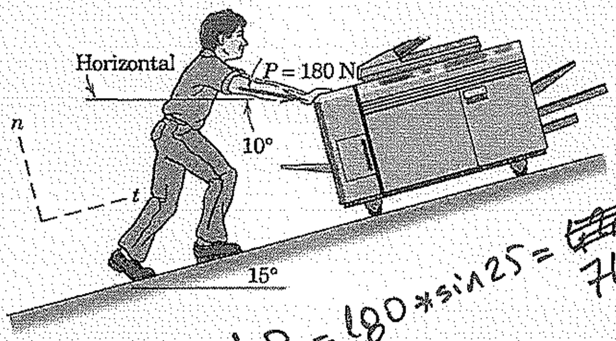
The contact point between the femur and tibia bones of the leg is at A. If a vertical force of 175 N is applied at this point, determine the components along the x and y axes. Note that the y component represents the normal force on the load-bearing region of the bones. Both the x and y components of this force cause synovial fluid to be squeezed out of the bearing space.



$F_y = 175 . \cos\alpha = 175 \frac{12}{13} = 161.5\,N$

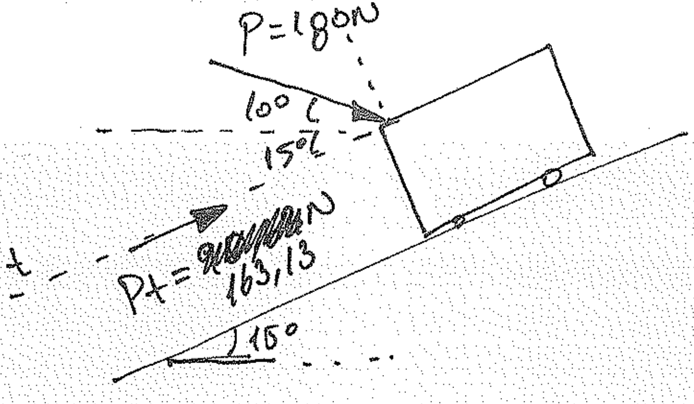
$F_x = 175 * \sin\alpha$

$F_x = 67{,}3N$

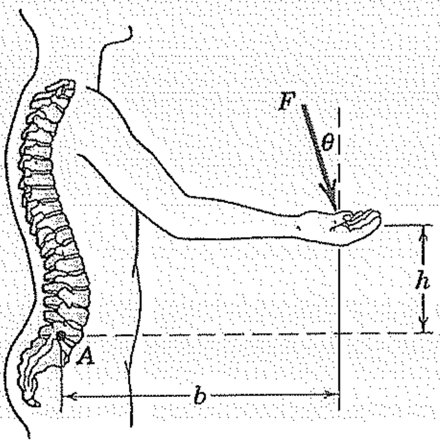


While steadily pushing the machine up an incline, a person exerts a 180 N force P as shown. Determine the components of P which are parallel and perpendicular to the incline.

$P_n = 180 * \sin 25 = 76{,}07\ N$



(Meriam P:45)



The lower lumber region A of the spine is the part of the spinal column most susceptible to abuse while resisting excessive bending caused by the moment about A of a force F. For given values of F, b, and h, determine the angle θ which causes the most severe bending strain. In order to maintain this static position, determine the reaction effects, which must be occurred at A, while assuming the A is a fixed support.

$$\sum \vec{M}_A = -F.\cos\theta.b - F\sin\theta.h$$

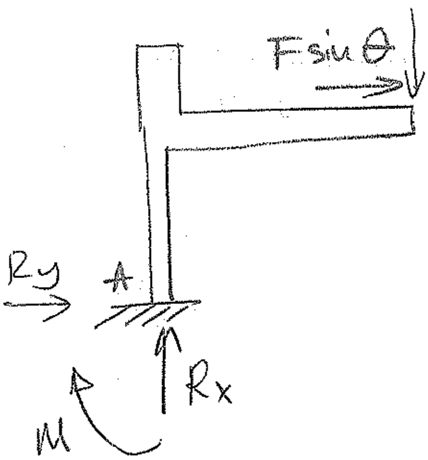
$$M_A = -F(\underbrace{\cos\theta\, b + \sin\theta\, h}_{f(\theta)}) \rightarrow$$ ~~[illegible]~~

In order to find the maximum value of θ, derivative of this trigonometric expression should be calculated and then be equalized to zero.

$$\frac{df}{d\theta} = -\sin\theta.b + \cos\theta.h = 0 \Rightarrow \tan\theta = \frac{h}{b}$$

$$\Rightarrow \theta^{-1} = \tan^{-1}\left(\frac{h}{b}\right)$$

If A is assumed to be a fixed support

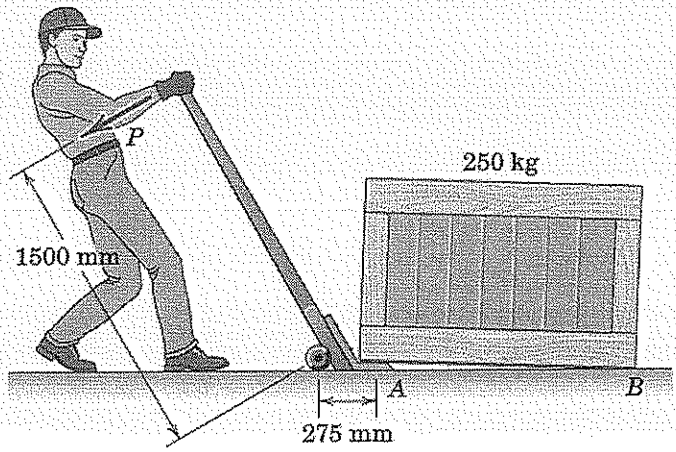


$$\sum \vec{F_x} = 0 \Rightarrow R_y + F\sin\theta = 0 \Rightarrow R_y = -F\sin\theta$$

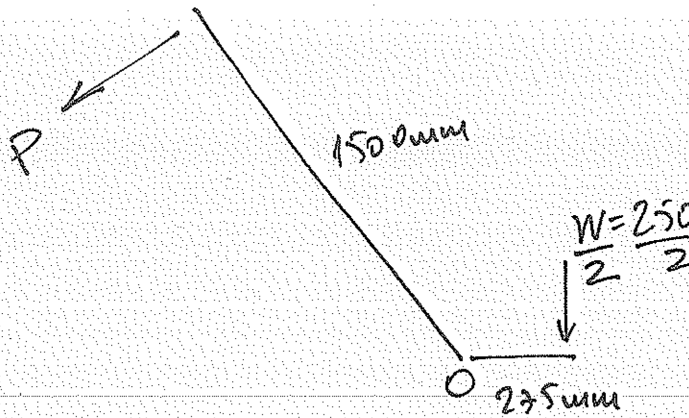
$$\sum \vec{F_y} = 0 \Rightarrow R_x - F\cos\theta = 0 \Rightarrow R_x = F\cos\theta$$

$$\sum M_A = 0 \Rightarrow -M - F\sin\theta\, h - F\cos\theta\, b = 0$$

$$M = -F(\sin\theta\, h + \cos\theta\, b)$$



Determine the force magnitude P required to lift one end of the 250-kg crate with the lever dolly as shown (Ans: 225 N).

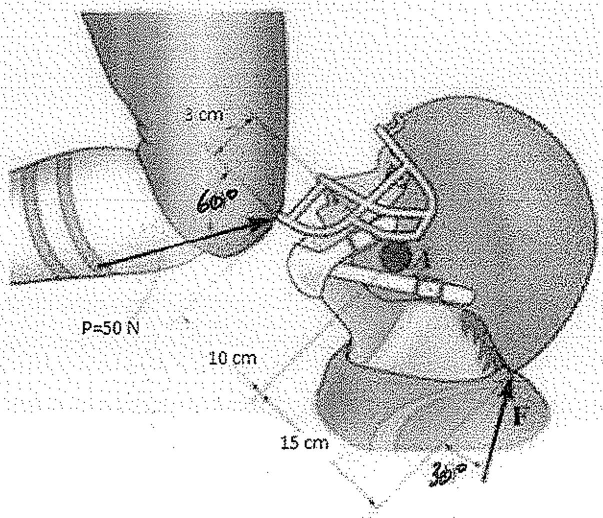


$\frac{W}{2} = \frac{250 * 9{,}81}{2} = \cancel{2452{,}5}\ 1226{,}25\ N$

$\Sigma M_O = 0 \Rightarrow$

$P\ 1500 - \cancel{2452{,}5}\ 1226{,}25 * 275 = 0 \Rightarrow P = 224{,}81\ N$

post participle of strike.



Serious neck injuries can occur when a football player is struck in the face guard of his helmet in the manner shown, giving rise to a guillotine mechanism. Determine the moment of the knee force P = 50N about point A. What would be the magnitude of the neck force $\boldsymbol{F}$ so that it gives the counterbalance moment about A?

(Şekildeki görülen, dizden kaska gelen P = 50N'luk kuvvetin A noktasında oluşturduğu momenti hesaplayınız. A noktası çevresindeki momentin sıfır olması için F kuvveti kaç N olmalıdır?)

$\curvearrowright (-)$

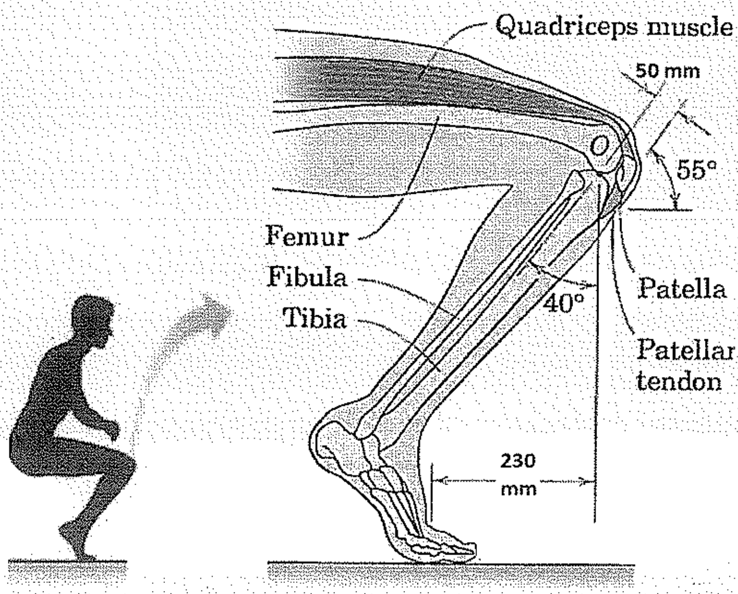
$$M = + P\cos 60 . 3cm - P\sin 60 \; 10 \, cm$$

$$M = (75 - 433) \, N \, cm = -358 \, N \, cm.$$

$\Sigma M_A = 0$ olması için

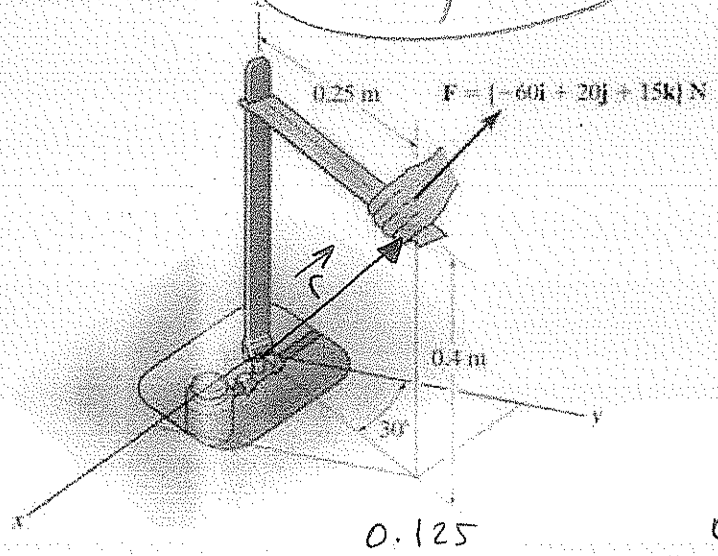
$$\Sigma M_A = -358 + F . \cos 30 * 15 = 0$$

$$F = 27,55 \, N$$



With his weight W equally distributed on both feet, a man begins to slowly rise from a squatting position as indicated in the figure. Determine the tensile force F in the patellar tendon and the magnitude of the force reaction at point O, which is the contact area between the tibia and the femur. Note that the line of action of the patellar tendon force is along its midline. Neglect the weight of the lower leg.

20 puan



The tool is used to shut off gas valves that are difficult to access. If the force F is applied to the handle, determine the component of the moment created about the z axis of the valve.

(F kuvvetinin, z ekseni çevresinde oluşturduğu momenti hesaplayınız.)

$$\vec{M} = \vec{r} \times \vec{F} = \{ \overbrace{(0{,}25 * \sin 30)}^{0.125} \vec{i} + \overbrace{(0{,}25 * \cos 30)}^{0.216} \vec{j} + 0{,}4 \vec{k} \} m \times$$

$$\{ -60 \vec{i} + 20 \vec{j} + 15 k \} N$$

$$\vec{M} = 2{,}5 \vec{k} - 1{,}875 \vec{j} + 12{,}96 \vec{k} + 3{,}24 \vec{i} - 24 \vec{j} - 8 \vec{i}$$

$$\vec{M} = \{ -4{,}76 \vec{i} - 25{,}875 \vec{j} + 15{,}46 \vec{k} \} Nm$$ 10 puan

$\Rightarrow$ z ekseni çevresindeki moment : 15,46 Nm   10 puan