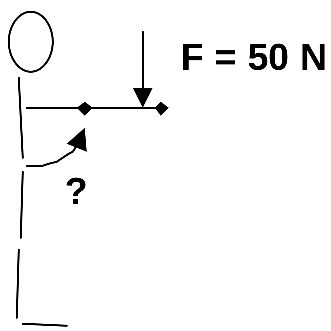
Department of Physical Therapy, University of Illinois at Chicago

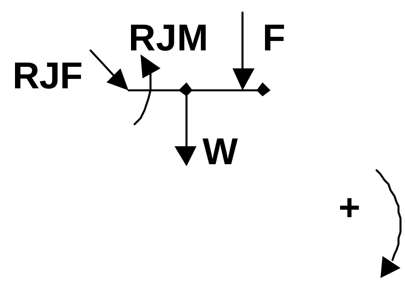
PT 617, KINESIOLOGY

Homework: Prime Mover

1. You perform an isometric manual muscle test with this patient. At 90 deg flexion, you apply a force of 50 N (about 10 lb).

(a) Draw the FBD for the arm.




(b) The weight of the arm W = 150 N, with moment arm $d_w$ = .25 m from the shoulder. The applied contact force F with moment arm $d_f$ = 0.5 m from the shoulder. Compute the resultant external load $SM_L$.

.

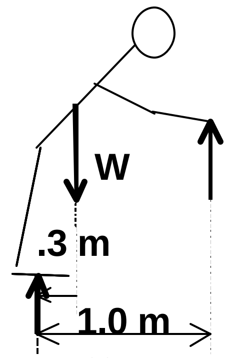
$SM_L = F \times d_f + W \times d_w = 50 \times .5 + 150 \times .25 = 62.5$ Nm

(c) Which muscle group is the prime mover RJM?

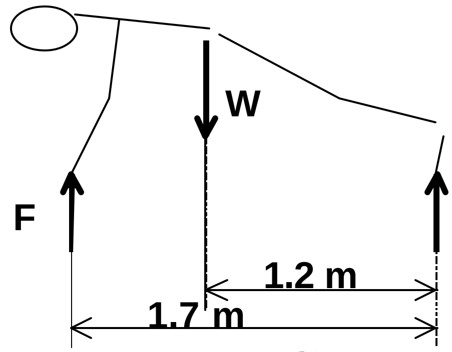
$SM = SM_L + RJM = 0$

$RJM = - SM_L = -62.5$ Nm OR THAT IS THE SHOULDER FLEXORS

2. A person is supported with both hands on a table in (a), and on the floor in (b), with feet on the floor (a bilaterally symmetrical position). Write the moment equilibrium equation using the point of foot contact force as the reference point. This person's weight is 700 N. Compute the resultant contact force F acting on both hands (assuming bilaterally symmetric for force distribution). Which one of the postures would distribute more force on the hands?




(a)

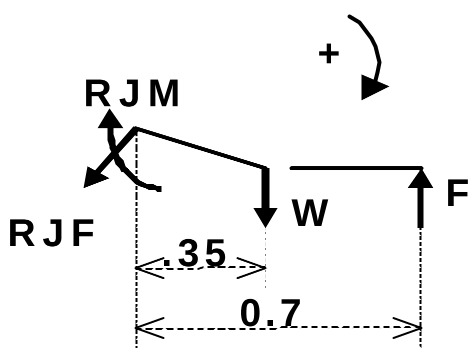



(b)

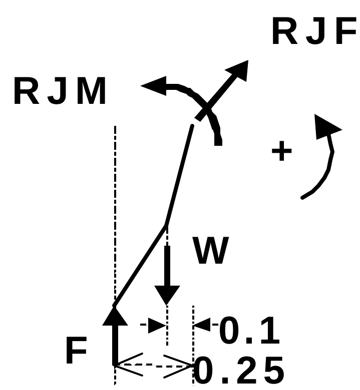
a) sum of moment about the foot SM = 0
sum of moment about the foot SM = F x 1.0 – W x 0.3 = 0
F = W x 0.3 /1.0 = 700 x .3/1 = 210 Nm

b) sum of moment about the foot SM = 0
sum of moment about the foot SM = F x 1.7 – W x 1.2 = 0
F = W x 1.2 /1.7 = 700 x 1.2 /1.7 = 494 Nm

3. For the **same** problem as in 2 after you have determined the force acting on the hand, draw FBD of the upper extremity (UE) only.




(a)




(b)

The weight of the UE is 150 N. Compute the RJM at the shoulder.

a) sum of moment about the shoulder SM = $SM_L$ + RJM + RJF x 0.0 = 0

$SM_L$ = – F x 0.7 + W x 0.35 = - 210 x 0.7 + 150 x .35 = - 112.7 Nm

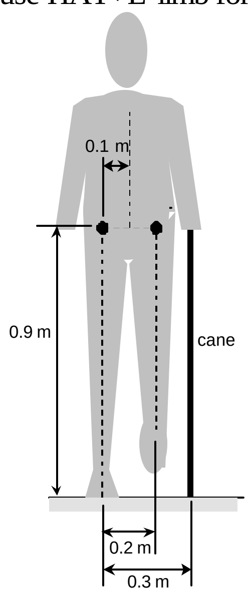
RJM = - $SM_L$ = 112.7 Nm (the extensors of the shoulder)

b) sum of moment about the shoulder SM = $SM_L$ + RJM + RJF x 0.0 = 0

$SM_L$ = – F x 0.25 + W x 0.1 = - 991 x 0.25 + 150 x .1 = - 232.7 Nm

RJM = - $SM_L$ = 232.75 Nm (the extensors of the shoulder)

4. A man weighing 500 N is standing still on his right leg holding a cane in his left hand, as shown in the figure. Suppose the person were press straight downward on the cane, such that there is a force (fc) between the cane and the ground 0.3m from R hip in horizontal distance. In addition to the normal component of fc, now there occurs a shear component of fc is 5% of the body weight (5% of 500 N) acting towards the right limb, due to the floor-cane friction. Find 1) what is the normal component of the fc to determine whether the friction has changed it or not, and 2) the resultant joint force (RJF) and resultant joint moment (RJM) at the hip of the right limb to determine whether the friction has changed them. (Hint, use the total body first to figure out the fcy like you did before, and use HAT+L-limb for your FBD)




Solution

Since we're told that the man is standing still, his body (including the cane) must be in equilibrium

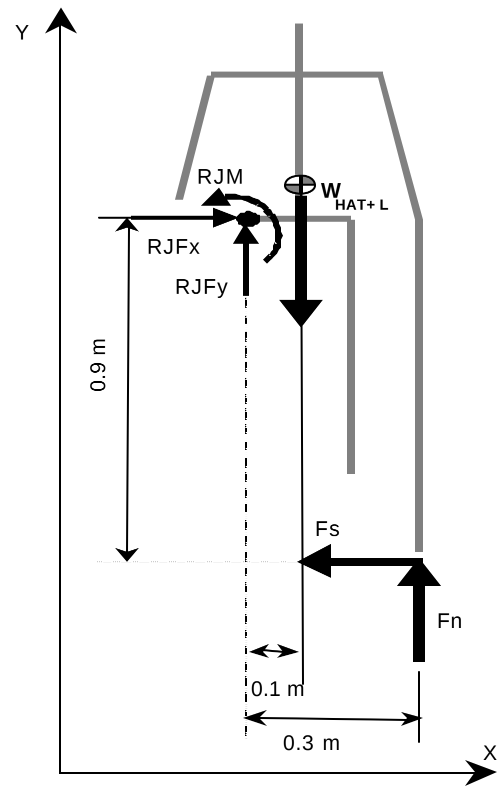
Part 1): To find the normal component of fc: Follow the solution for problem 3 in HW 4.
-Set-up your free body diagram and use the equation Σ M = 0.
-Note we are not given the ground reaction force under the right limb, but if you take the moments about the ground reaction force you eliminate it from the equation.
Ans: The normal component of fc = fn = 166.7 N. The normal component of fc is not changed by friction.

Part 2)
<u>Step 1</u>: Identify the basic approach that will be used to solve the problem. Since the person is in equilibrium:

$\Sigma M = 0$

$\Sigma F = 0$

Step 2: Draw the Free Body Diagram using HAT + L limb as the system




Step 3:

a) Compute the magnitude of the weight if the HAT + L limb appearing in the free body diagram.

|weight| = (mass) * (acceleration due to gravity)

$|W_{HAT+L}|$ = 40 x 10 = 400 N (acting downwards, therefore -400 N)

b) Compute the magnitude of the shear force (fs) of fg.

fs = 0.05 x 500 N = 25 N

Step 4: Construct the equations of equilibrium for our system.

a) Find the amount of each force in the x and y directions

| Force | Fx | Fy |
|---|---|---|
| WHAT +L | 0 | -400N |
| RJFx | RJFx | 0 |
| RJFy | 0 | RJFy |
| fn | 0 | 166.7 N |
| fs | -25 N | 0 |

b) Choose an axis of rotation to compute the moments about.

Since we are given that sum of moments about the R hip = 0, we commute the moments with respect to the R hip.

c) Compute the moment produced by each force and external moment about the axis of rotation chosen.

| Force | moment arm (r) | \|F\| | \|M\| = r \|F\| | M |
|---|---|---|---|---|
| WHAT + L | 0.125 m | 400 N | 50 Nm | – 50 Nm |
| RJFx | 0 | \|RJFx\| | 0 | 0 |
| RJFy | 0 | \|RJFy\| | 0 | 0 |
| RJM | – | – | \|RJM\| | + RJM |
| fn | 0.3 m | 166.7 N | 50 Nm | +50 Nm |
| fs | 0.9 m | 25 N | 22.5 Nm | -22.5 Nm |

d) Create the equations of equilibrium by adding the corresponding table column

$\Sigma$ Fx = 0: -25 N + RJFx = 0

$\Sigma$ Fy = 0: – 400 N + 166.7 N + RJFy = 0

$\Sigma$ M = 0: – 50 Nm + 50 Nm + -22.5 Nm + RJM = 0

Step 5: Solve the equations of equilibrium to find the unknown values.

RJFx = **25 N**
**RJFy = 233.3 N** (i.e. RJF = 233.3 N upward)
**RJM = +22.5 Nm** (RJM is acting counter clockwise direction, i.e. opposite to that shown in our free body diagram.)

Ans: Friction has changed the RJF and the RJM about the hip joint.