Coaching During Discussion Sessions (partial student solutions)

INDIVIDUAL TASKS:

On the following page is an introductory physics problem – pretend that your teaching team has decided to use this problem in the next discussion session.

1. Solve this problem by yourself.
2. Write down some notes about how you would prepare for this discussion session. Use the Discussion Preparation sheet as a guide.
   a. What is the learning focus for this problem that you will emphasize?
   b. What do you expect students to have difficulty with?
   c. What questions can you ask students?
3. Write up a detailed "solution" to this problem that you would hand out to your students at the end of class.

INDIVIDUAL & GROUP TASKS:

Following the problem statement are 8 partial student solutions to the problem. For this activity, you should pretend that you are in the middle of teaching a discussion session with this problem. As you circulate the room, you observe what students have written on their papers so far.

NOTE: Usually there will only be 4-5 groups in your discussion, but it is possible that students might be writing some things down individually. Pretend that students 1 & 2 are in the same group, students 3 & 4 are in the same group, 5 & 6 are in the same group, and 7 & 8 are together. The remaining members of each group have not written anything down.

1. Which group would you intervene with first? (Which group do you think needs the most help?)
2. How would you coach each group on problem solving?
3. Are there any issues common to all student groups? (If so, then you might be able to stop the session briefly for some whole-class coaching. What could you say?)

Be prepared to share your responses to these questions with your peers during TA Orientation.

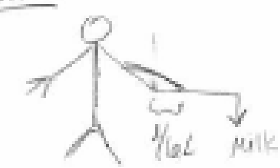
NOTE: These partial student solutions were actually taken from individual solutions to a 1201 final exam problem in Fall 2005, from two different lecture sections. The problem was chosen because it is similar to most group problems given in discussion sessions.

Problem:

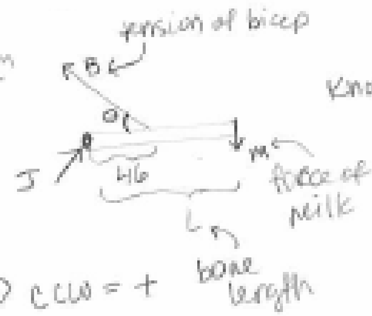
Your task is to design an artificial joint to replace arthritic elbow joints in patients. After healing, the patient should be able to hold at least a gallon of milk (3.76 liters) while the lower arm is horizontal. The bicep muscle is attached to the bone at the distance 1/6 of the bone length from the elbow joint, and makes an angle of 80^0 with the horizontal bone. For how strong of a force should you design the artificial joint? (The weight of the bone is negligible.)

STUDENT #1:

Picture



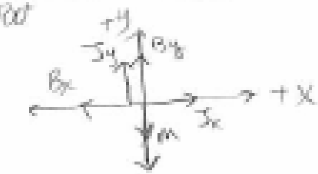
Diagram



$\circlearrowleft$ CCW = +

Know: M
$\theta = 90°$
L

Force Diagram



$B_x = B\cos\theta$ $J = \sqrt{J_x^2 + J_y^2}$
$B_y = B\sin\theta$
$\tan\theta = B_y/B_x$

Approach
use forces $\Sigma F = 0$
use torques $\Sigma \tau = 0$
ignore bone weight
By Newton's 3rd Law the force of the joint on the bone is equal to the force of the bone on the joint.

$\Sigma F_x = J_x - B_x = 0$
$\Sigma F_y = J_y + B_y - M = 0$
$\Sigma \tau = B_y \frac{L}{6} - ML = 0$ or $B\sin\theta - \frac{L}{6} - ML$

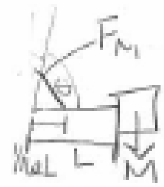
STUDENT #2:

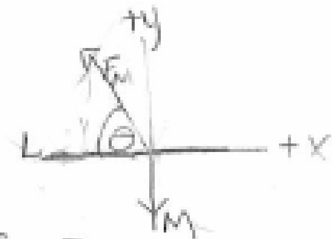
KNOW:

M - 3.76 LITERS.

θ - 80°

$L_2 = 1/16\ L_1$





WEIGHT OF BONE NEGLIGIBLE. Fm = FORCE OF MUSCLE

APPROACH:

Q. HOW STRONG A FORCE SHOULD THE ARTIFICLE JOINT BE MADE

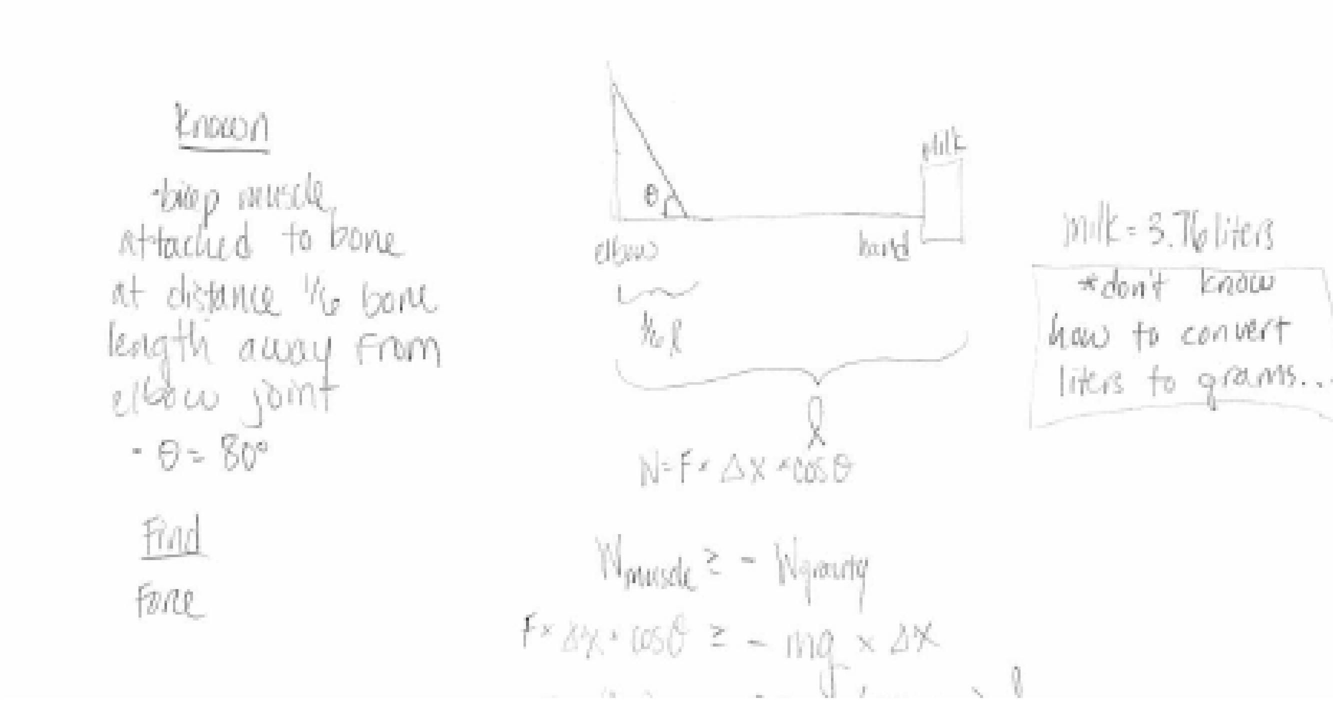
USE FORCES NEGLECT BONE MASS

$\sum_x - L_x \cos\theta - M_x = 0$ $\quad \sum = F_{m_y} \sin\theta - M_y = 0$

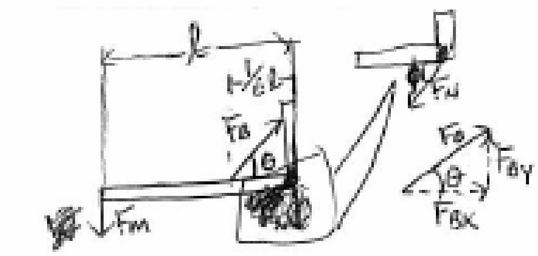
$\tau = rF_\perp$ $\quad \sum\tau = F\cos\theta - m = 0$

TENSION OF MUSCLE $F_{m_x} = M_x - L_x$

STUDENT #3:


Known
-bicep muscle attached to bone at distance 1/6 bone length away from elbow joint
- θ = 80°
Find
force
milk
elbow
hand
1/6 l
l
W = F × ΔX × cos θ
W_muscle ≥ - W_gravity
F × ΔX × cos θ ≥ - mg × ΔX
milk = 3.76 liters
*don't know how to convert liters to grams...

STUDENT #4:



$$F_{By} = F_B \sin\theta$$
$$F_{Bx} = F_B \cos\theta$$

$$F_{Nx} = F_N \cos\theta$$
$$F_{Ny} = F_N \sin\theta$$

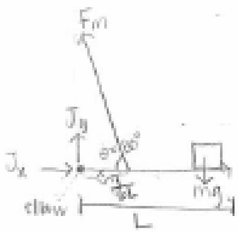
$$\sum F_x = F_{Bx} + F_{Nx} = 0 = F_B \sin\theta + F_{Nx} = 0 \Rightarrow F_B \overset{\cos}{\cancel{\sin}}\theta = F_{Nx} \quad (1)$$

$$\sum F_y = F_{By} + (F_m - F_{Ny}) = 0 = F_B \overset{\sin}{\cancel{\cos}}\theta + (F_m - F_{Ny}) = 0 \Rightarrow F_{Ny} = F_m + F_B \quad (2)$$

$$(3)\ \sum \tau = (F_m \cdot l) + \left(F_{By} \cdot \frac{l}{6}\right) = F_m l + F_B \overset{\sin}{\cancel{\cos}}\theta \cdot \frac{l}{6} = 0$$

STUDENT #5:

The objective of the problem is to determine the force of the elbow joint so that it can support 3.76L while lower arm is in horizontal



$\cos\theta = \frac{x}{Fm}$

$\sin\theta = \frac{J_x}{Fm}$

$\tau = F \cdot d\sin\theta$

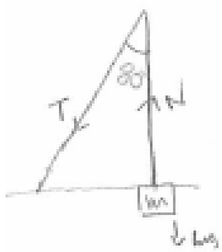
$3.76 \text{ liter} \left(\frac{10^{-3}\,\cancel{m^3}}{1 \text{ liter}}\right)\left(\frac{10^3\,kg}{\cancel{m^3}}\right) = 3.76\,kg$

$\tau_{joint} = 0$

$\tau_{muscle} = Fm \cdot \frac{1}{6}L\sin 80$

$F_{elbow} = mg$

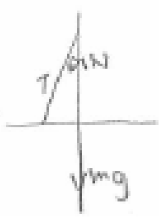
STUDENT #6:



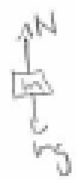
$\theta = 80°$
$m = 376$ liters.

$F = mg$

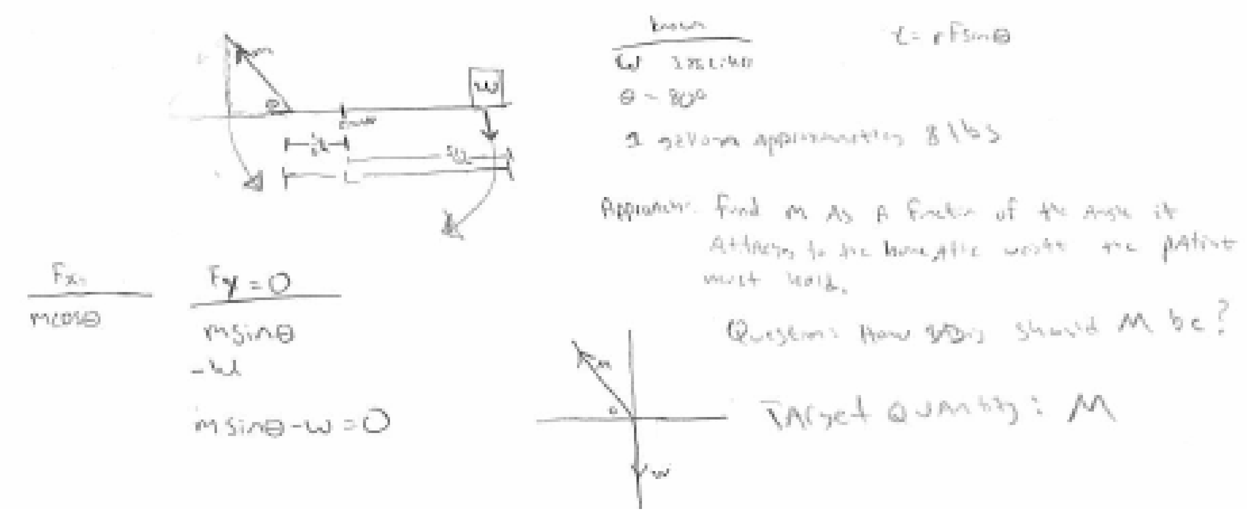
question ?
how strong a force should you design the artificial joint?



$\Sigma F_x = 0$
$\Sigma F_y = N + T\cos\theta - mg$ $\quad N + T\cos\theta = mg.$



STUDENT #7:


W
Known
θ ~ 80°
τ = rFsinθ
Approach: Find M as a function of the angle it attaches to the bone, the weight the patient must hold.
Question: How big should M be?
Target Quantity: M
Fx
Mcosθ
Fy = 0
Msinθ
-W
Msinθ - W = 0

STUDENT #8:

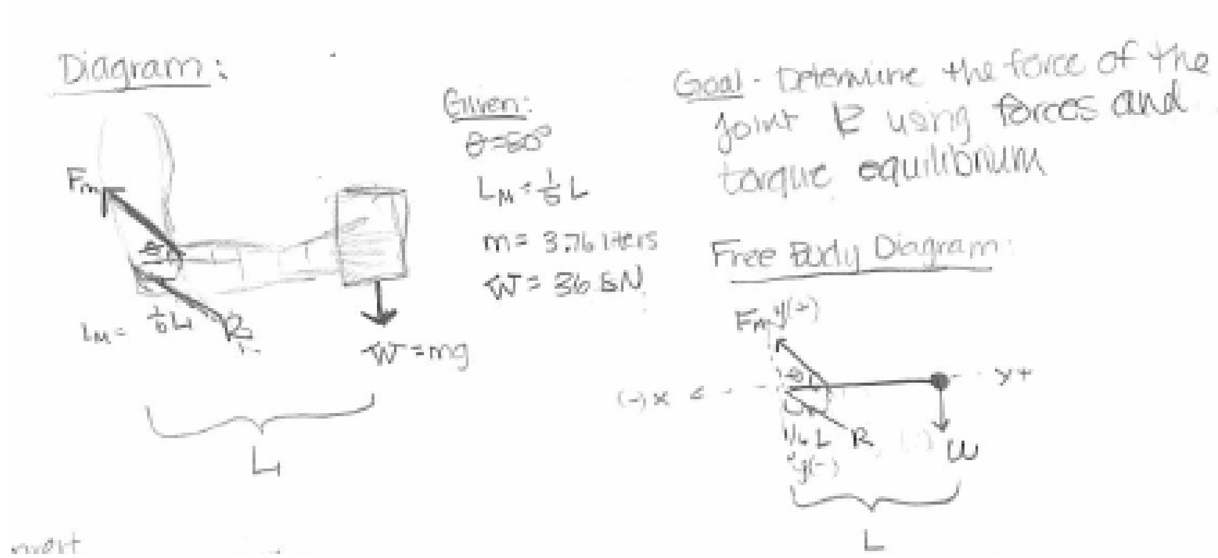


Diagram:
Given:
θ=60°
m= 3.76 liters
W= 36.6N
W=mg
Goal - Determine the force of the joint R using forces and torque equilibrium
Free Body Diagram
R
L
W