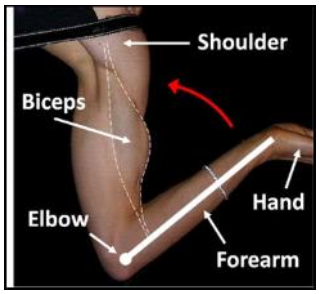
Quiz 2

Tuesday, January 19, 2021 11:39 AM

The biceps brachii (commonly known as biceps) muscles are responsible for bending your arm at the elbow. They move your forearm towards your shoulder (the red arrow shows this motion, also known as adduction). See diagram at right. Your biceps muscles attach to your forearm a few cm away from your elbow.

(a) Using relevant physical concepts we have discussed this term, explain why the biceps muscles do not attach directly to the elbow, but instead attach to the forearm a few centimeters away from the elbow. Use words, diagrams, graphs, etc!

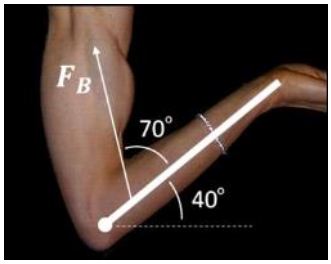


$\Sigma \tau = I\alpha$, $\tau = r \times F$, where r is the lever arm, which is displacement from axis of rotation to location of force.

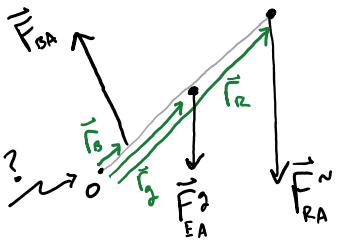
if $r = 0$, $\tau = 0$

if $\tau_{Bicep} = 0$, you can't rotate arm

(b) While lifting a rock, Elle Beau's biceps make an angle of 70 degrees with her forearm, and her forearm makes an angle of 40 degrees with the horizontal as shown to the right. The distance from Elle's elbow to her hand is 26.7 cm, and her biceps attach to her forearm 3.4 cm away from her elbow. Elle's forearm has a mass of 1.46 kg, and a center of mass midway between her elbow and her hand. If she is holding the 5 kg rock stationary in her hand, how much force are her biceps exerting on her forearm? (assume no other muscles are exerting forces)



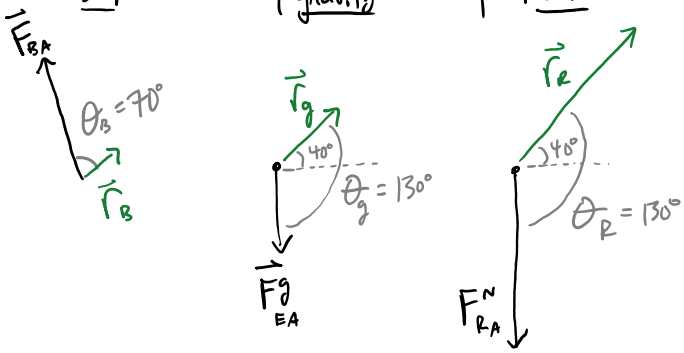
e-FBD (Arm)



$\vec{F}$ elbow

Torque Cross Product Vector operations

Bicep | gravity | Rock



$\Sigma \tau_O = I_O \alpha_O^{\circ} \Rightarrow \tau_B + (-\tau_g) + (-\tau_R) = 0$

$|\vec{r}_B||\vec{F}_{BA}|\sin\theta_B - |\vec{r}_g||\vec{F}^g_{EA}|\sin\theta_g - |\vec{r}_R||\vec{F}^N_{RA}|\sin\theta_R = 0$, $F^g_{EA} = M_A g$, $F^N_{RA} = M_R g$

$$\therefore \quad |\vec{F}_{BA}| = \frac{|\vec{r}_g||\vec{F}_{EA}|\sin\theta_g + |\vec{r}_R||\vec{F}^N_{RA}|\sin\theta_R}{|\vec{r}_B|\sin\theta_B} = \boxed{359\ N}$$

Rubric
(a) 1.5 pts
(b)

Problem Orientation	Solution Exploration	Solution Execution	Solution Evaluation
1.5 pts - eFBD 1.5 pts - vector operations 1 pt - 2nd law torque eq. 0.5 pt - torque = r x F =r*F*sin(theta) eq. 0.5 pts - F_g = mg	0.5 pts - F_R = mg	1.0 pts - sign of torques 1.5 pts - application of 2nd law	0.5 pts - Correct answer and units