Physics 253 In-Class Worksheet  
01 December 2005  
*Do You Believe in Statics?*

1. Suppose a person holds their arm as follows:

![Diagram of arm with biceps muscle](image)

The biceps muscle is attached to the forearm 3.6 cm from the elbow, and the center of mass of the forearm is located 14 cm from the elbow. The entire length of the forearm to the end of the hand is 32 cm. The forearm mass is 2.5 kg.

(a) Find the tension in the biceps muscle if the angle between the biceps and the forearm is 80°. Remember to draw a free body diagram showing all component forces, and also be sure you identify the pivot point.

(b) Find the contact forces exerted by the elbow joint.

(c) If the angle is 10° instead of 80° between the biceps and the forearm bone, how does this change the tension?

(d) What are the contact forces on the elbow joint in this case? Note that these are what eventually lead to chronic joint pain and related injuries from improper exercise form!

(e) Based on your answers, which of the two positions requires less effort, and which position would be less injury-prone?

(f) Now suppose a 10 kg mass is held in the hand (*i.e.* 32 cm from the elbow). Recalculate the tension in the biceps and the contact forces on the elbow for the angles 10° and 80°.