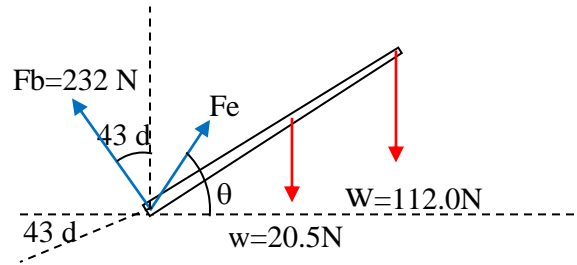


Q- A patient in therapy has a forearm that weighs 20.5 N and lifts a 112.0 N weight. The only other significant forces on his forearm come from the biceps muscle (which acts perpendicularly to the forearm) and the force at the elbow. If the biceps produce a pull of 232 N when the forearm is raised 43° above the horizontal, find the magnitude and direction of the force that the elbow exerts on the forearm.



The forces acting on the forearm are

- Weight of forearm $w = 20.5 \text{ N}$ vertically downward
- Weight lifted $W = 112.0 \text{ N}$ vertically downward
- Force due to biceps $F_b = 232 \text{ N}$ 43° with vertical and
- Force of elbow $F_e = ?$ θ above the horizontal (say)

Resolving last two forces in horizontal and vertical direction and as for the equilibrium the net force in any direction should be zero, we get

Horizontally

$$F_e \cos \theta - F_b \sin 43^\circ = 0$$

Or $F_e \cos \theta = F_b \sin 43^\circ = 232 * 0.682 = 158.22 \text{ N}$ ----- (1)

Vertically

$$F_e \sin \theta + F_b \cos 43^\circ - W - w = 0$$

Or $F_e \sin \theta = W + w - F_b \cos 43^\circ = 112.0 + 20.5 - 232 \cos 43^\circ = -37.17 \text{ N}$ ----- (2)

Squaring and adding the two equations we have

$$F_e^2 = 158.22^2 + (-37.17)^2$$

Gives $F_e = 162.53 \text{ N}$

And dividing equation 2 by equation 1 we get

$$\tan \theta = -37.17 / 158.22 = -0.235$$

gives $\theta = -13.22^\circ$ (below horizontal).