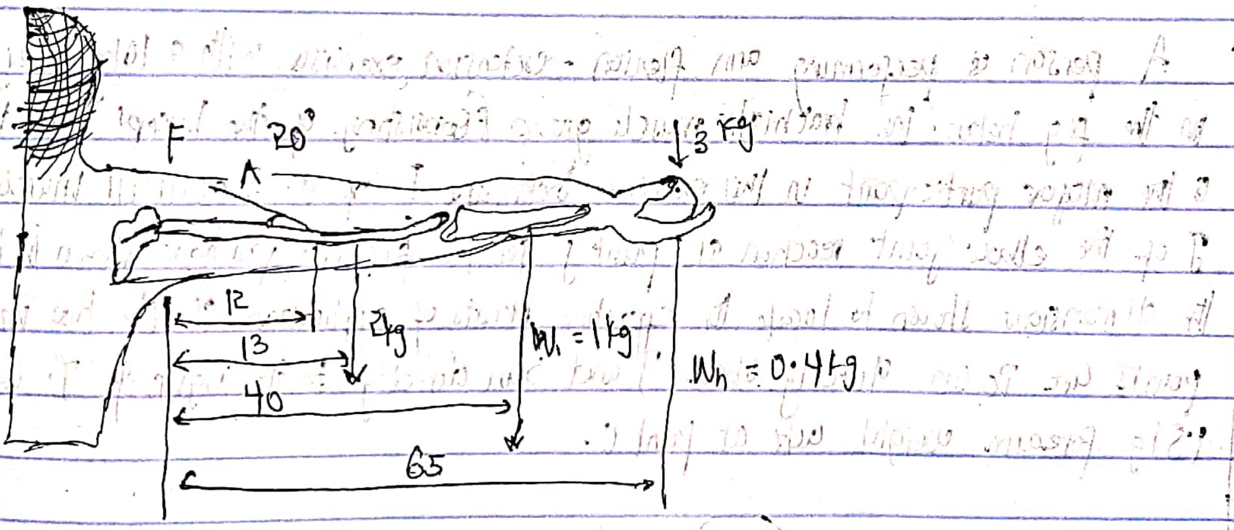
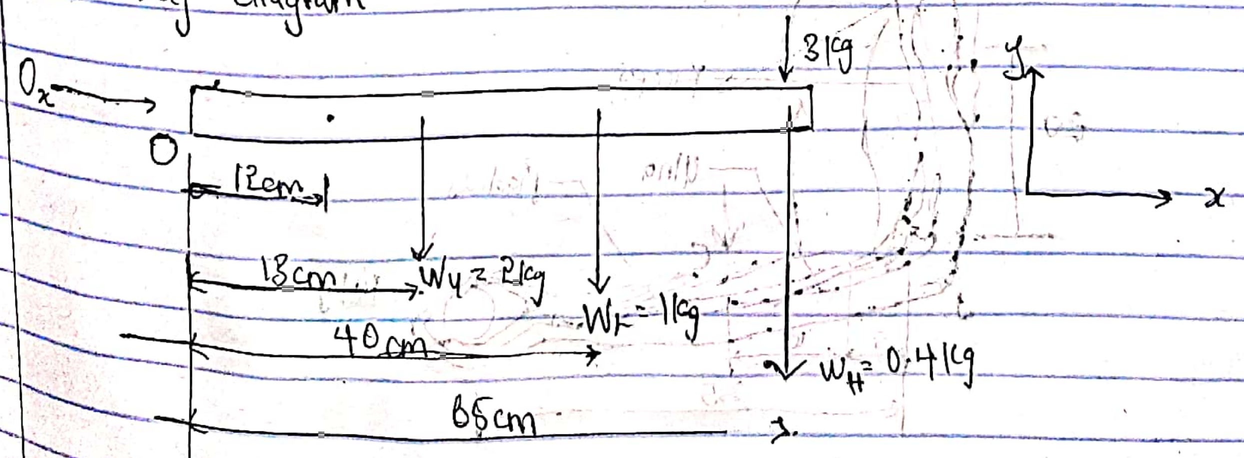
HAASTRUP OLUWADOYINSOLA MERCY
15/ENG06/032
MECHANICAL ENGINEERING
MEE 514
ASSIGNMENT 7

A man is holding a 3-kg weight in his hand with the entire arm flexed horizontally as shown in the figure below. A tensile force in the deltoid muscle prevents the arm from rotating about the shoulder joint O: this force acts at the 20° angle. Determine the force exerted by the deltoid muscle on the upper arm at A and the X and Y components of the reaction force at the shoulder joint O. The weight of the upper arm lower arm and the hand are 2kg, 1kg and 0.4kg respectively, and are acting at points shown in the fig below. The dimensions are in cm.



Solution.

Free body diagram



$1cm = 1 \times 10^{-2} m$ ($1cm = 100m$)

Taking moment about point O

$\Sigma M_o = 0$

$12 F \sin 20 = 13 W_u + 40 W_L + 65 (W_h + W_B)$

$12 \times F \times \sin 20 = 13 \times 2 + 40 \times 1 + 65 \times (3 + 0.4)$

~~$12 \times F \times 0.34202 = 26 + 40 + 221$~~

$12 \times F \times 0.34202 = 26 + 40 + 221$

$4.10424 F = 287$

$F = 69.9 kg$

$\therefore F_D$ at point A $= F = 69.99 \times 9.81$

$= \cancel{686.7}$ $686.7N$

Equilibrium of forces along the y-axis $\Sigma F_y = 0$

$F \sin 20 - W_u - W_L - W_h = 0$

Y component of force at ~~F_D~~ deltoid joint $= F \sin 20$

$= 69.99 \times \sin 20$

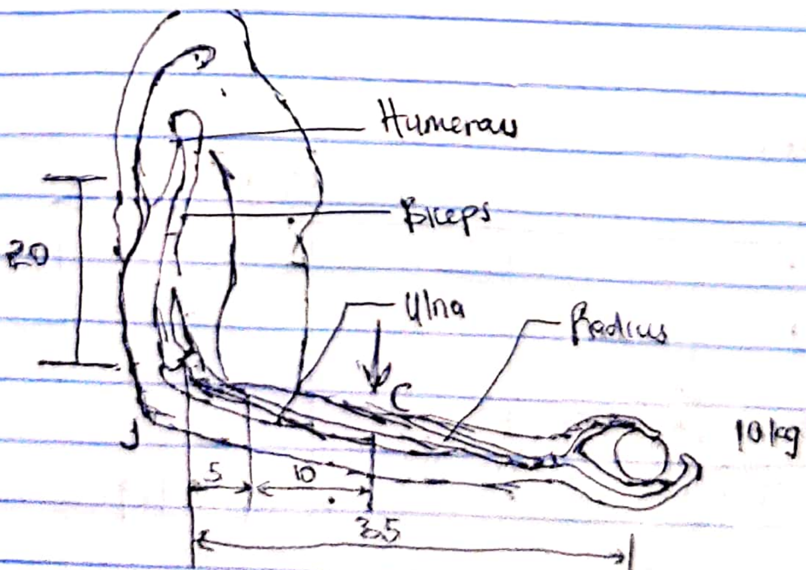
$= 23.94 kg$

X component of the force at deltoid joint $= F \cos 20$

$= 69.99 \times \cos 20$

$= 65.78 kg$

A person is performing arm flexion - extension exercise with a 10kg weight as indicated [in] the fig below. The brachialis muscle group (consisting of the biceps and brachialis muscle) [are] the major participant in this exercise. Determine F of the brachialis muscle group force and [the] [magnitude] of the elbow joint reaction at point J for the forearm position shown in the figure. Take [the] dimensions shown to locate the effective points of application of the two muscle groups, [these] points are 20 cm directly above J and 5cm directly to the right of J. Consider that the [1]·5kg forearm weight acts at point C.



Assumptions

There is equilibrium of moment about the elbow joint i.e algebraic sum about the rotation of axis O is zero.

Summation of moment about O is zero

Weight of the arm $C = 1.5\,kg$

Let $F \rightarrow$ Force

Weight on the palm $= 10\,kg$

$\tan\theta = 5/20$

$\theta = \tan^{-1}\left(\frac{5}{20}\right)$

$\theta = 14.04^\circ$

Taking moment about E

$\Sigma M_E = 0$

$\cancel{F\cos\theta \times 67}$

$(F\cos\theta \times) = (C \times r) + (F \times r_c)$

$[F\cos(14.04) \times (5 \times 0.01)] = [(\overset{1.5}{\cancel{15}} \times 0.01) \times C] + [(35 \times 0.01) \times (10 \times 9.81)]$

$F \times 0.049 = (0.015 \times 1.5 \times 9.81) + 34.335$

$0.049F = 2.207 + 34.335$

$0.049F = 36.542$

$F = 745.76N$ $\cancel{(9.81kg = 1N)}$

$F = 74.61kg$ $(9.81kg = 1N)$

Considering Force along x-axis; $\Sigma F_x = 0$

$\Sigma_x = F\sin 14.04^\circ = 74.6\sin 14.04$

$= 18.09\,kg$

Considering force along y-axis; $\Sigma F_y = 0$

$\Sigma y = F\cos(14.04) - 1.5 - 10 = 74.6\cos(14.04) - 1.5 - 10 = 60.87\,kg$

Resultant Force $E = \sqrt{(\Sigma x^2 + \Sigma y^2)}$

$\sqrt{(18.09^2 + 60.87^2)}$

$E = \sqrt{4032.41}$

$= 63.50\,kg.$