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16/ENG06/1088
Mechanical Engineering
MEE 514
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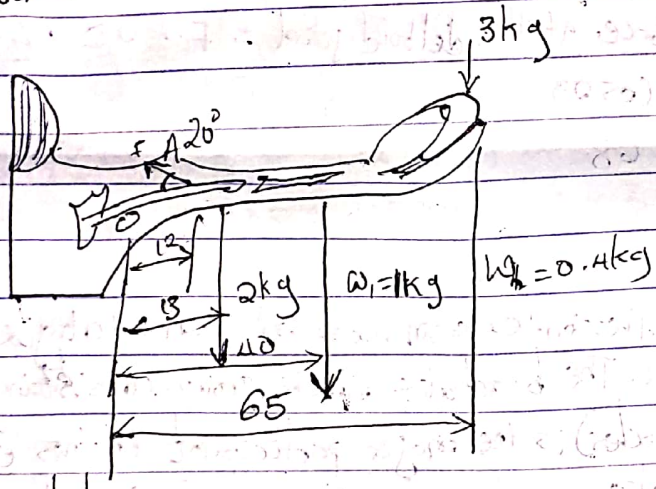
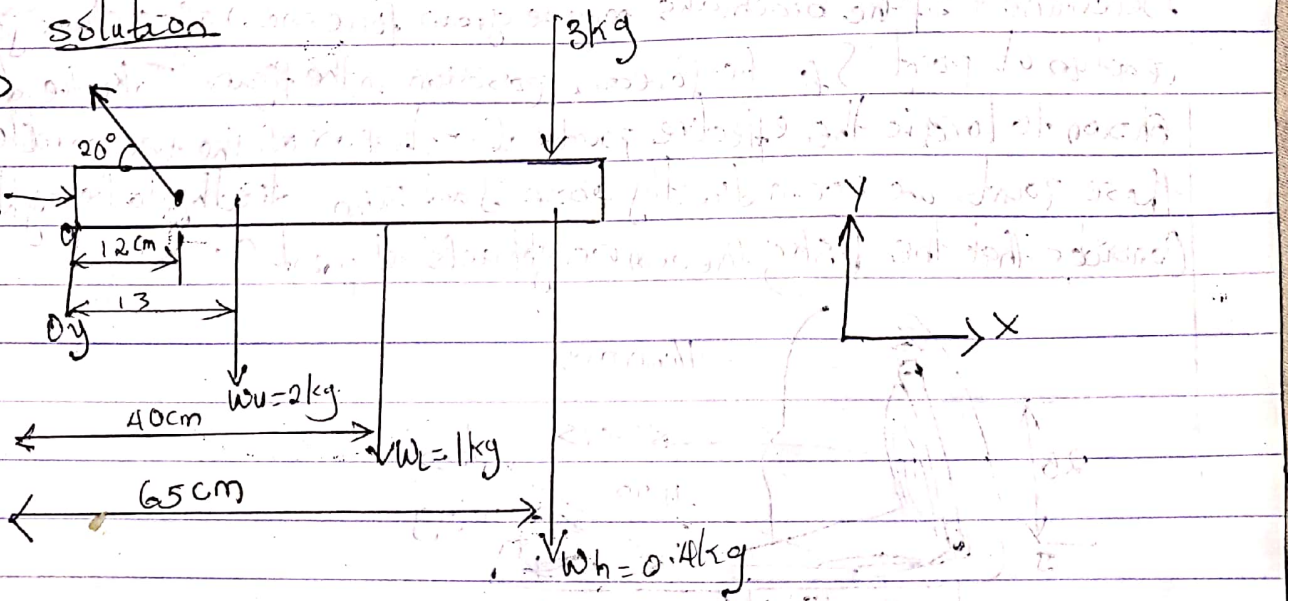
Assignment

1) 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 upperarm 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 show below.



Solution

FBD



Taking moments about point O

$\sum M_O = 0 \quad 12F\sin 20 = 13W_u + 40W_L + 65(W_h + W_B)$

$12 \times F \times \sin 20 = 13 \times 2 + 40 \times 1 + 65 \times (3 + 0.$

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

$4.10424F = 287$

$F = 69.9\,kg$

∴ force exerted on the deltoid muscle at A is $F = 69.9kg \times 9.81$

$= 685.7N$

Equilibrium of forces along the y-axis $\sum f_y = 0$

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

∴ Y component of the force at the deltoid joint $= F\sin 20$

$= 69.9 \times \sin 20$

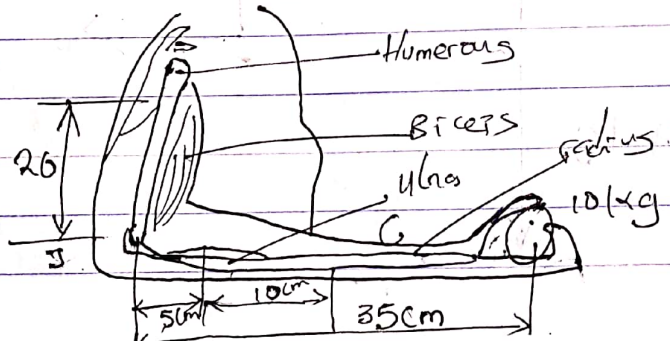
$= 23.9kg$

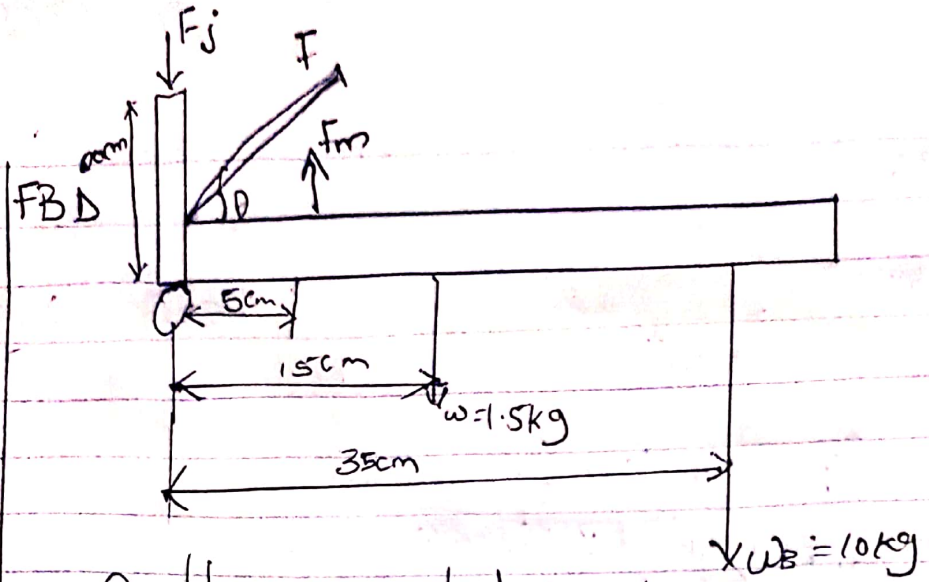
X component of the force at the deltoid joint $= F\cos 20$: $\sum x - F\cos 20 = 0$

$= 69.9 \times \cos 20$

$= 65.68$

2) A person is performing arm flexion-extension exercise with a 10kg weight as indicated in the figure below. The brachalis muscle group (consisting of the biceps and brachialis muscles) is the major participant in this exercise. Determine F of the brachialis muscle group force and J of the elbow joint reaction at point J for the forearm position in the figure. Take the dimensions shown to locate the effective points of application of the two muscle groups; these points are 20cm directly above J and 5cm directly to the right of J. Consider that the 1.5kg forearm weight acts at point C.





Equilibrium of moment about point O

$\Sigma m_O = 0$

To find the angle between F and the flexion

$\tan\theta = \frac{5}{20}$

$\theta = \tan^{-1}(5/20)$

$= 14.04°$

Taking about point O

$\Sigma M_O = 0$

$F\cos\theta \times 5 = w \times 15 + w_B \times 35$

$F\cos 14.04 \times 5 = 1.5 \times 15 + 10 \times 35$

$4.8506F = 22.5 + 350$

$4.8506F = 372.5$

$F = 76.79$ kg

Considering force along x-axis

$\Sigma F_x = 0$

$\Sigma x - F\sin 14.04 = 0$

$\Sigma x = 76.79\sin 14.04$

$= 18.63$

Considering the forces along the Y-axis $\Sigma f_y = 0$

$F\cos 14.04 - 1.5 - 10 = 0$

$76.79\cos 14.04 - 1.5 - 10$

$74.496 - 1.5 - 10$

$= 62.996$

Resultant force

$= \sqrt{\Sigma x^2 + \Sigma y^2}$

$= \sqrt{(18.63)^2 + (62.996)^2}$

$= \sqrt{347.0769 + 3968.496}$

$= \sqrt{4315.5729}$

$= 65.7 \text{ kg}$

$\therefore$ reaction at J $= 65.7 \text{ kg}$