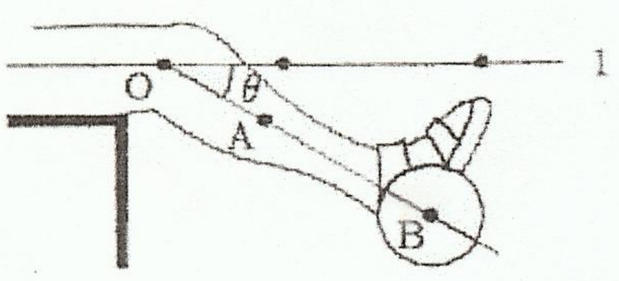
Worksheet 3

Problem 2 – Moments

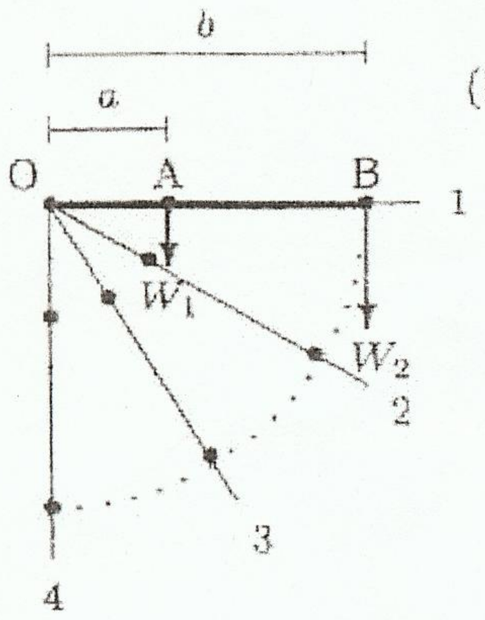
As illustrated in figure a below, consider an athlete wearing a weight boot, and from a sitting position, doing lower leg flexion/extension exercises to strengthen quadriceps muscles. The weight of the athlete's lower leg is $W_1 = 50$ N and the weight of the boot is $W_2 = 100$ N. As measured from the knee joint at O, the center of gravity (A) of the lower leg is located at a distance $a = 20$ cm and the center of gravity (B) of the boot is located at a distance $b = 50$ cm.

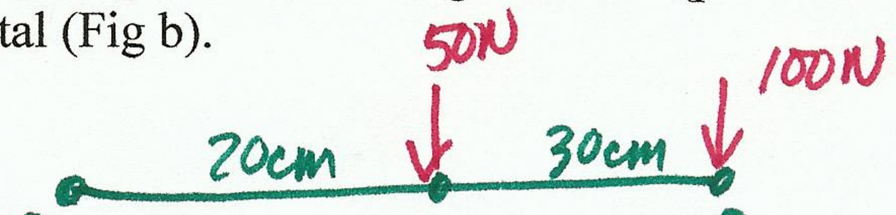
Determine the net moment generated about the knee joint when the lower leg is extended horizontally (position 1), and when the leg makes and angle of 30° (position 2), 60° (position 3), and 90° (position 4) with the horizontal (Fig b).

(a)



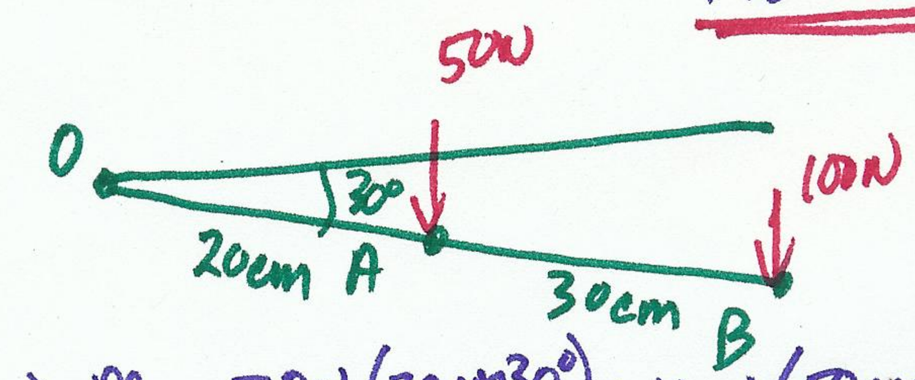
(b)





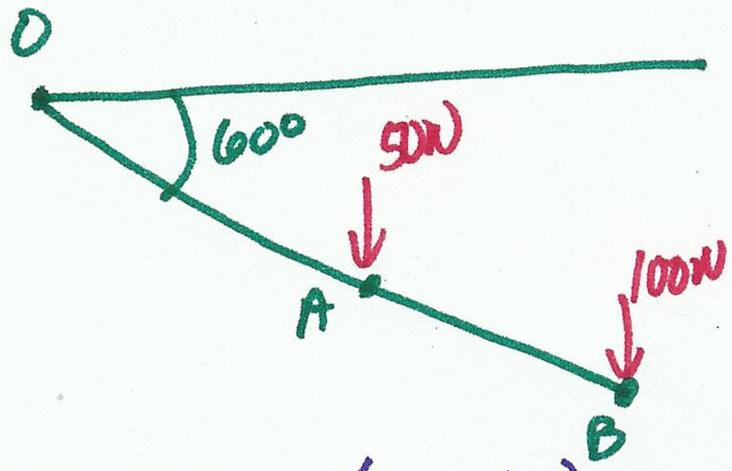
$\curvearrowright M_O = 50\,N(20cm) + 100N(50cm) = 6000\,N\,cm$

$M_O = 60.0\,Nm \curvearrowright$



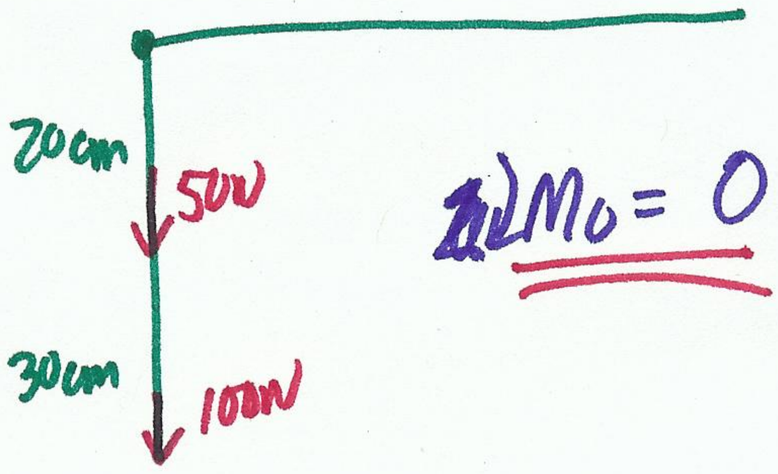
$\curvearrowright M_O = 50N(20\cos 30°) + 100N(50\cos 30°) = 5196\,N\,cm$

$M_O = 52.0\,Nm \curvearrowright$



$\curvearrowright M_O = 50N(20\cos 60°) + 100N(50\cos 60°) = 3000\,N\,cm$

$M_O = 30.0\,Nm \curvearrowright$



$\curvearrowright M_O = 0$, NO $d_\perp$