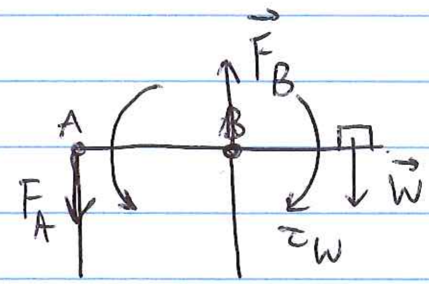
Static equilibrium: $\underline{\vec{F}_{net} = 0}$ AND $\underline{\tau_{net} = 0}$

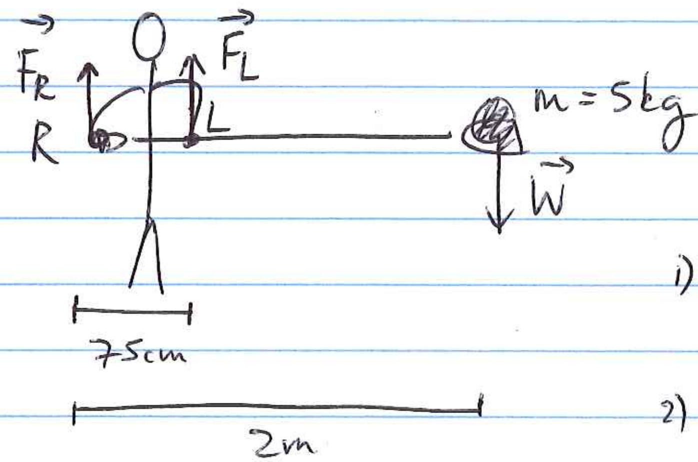
$\downarrow$ $\vec{a} = 0$ $\qquad$ $\downarrow$ no rotation



$\tau^B_{net} = 0$

$F_{net} = 0 = \vec{W} + \vec{F}_A + \vec{F}_B$

* Example: massless shovel with a mass of 5kg at the end

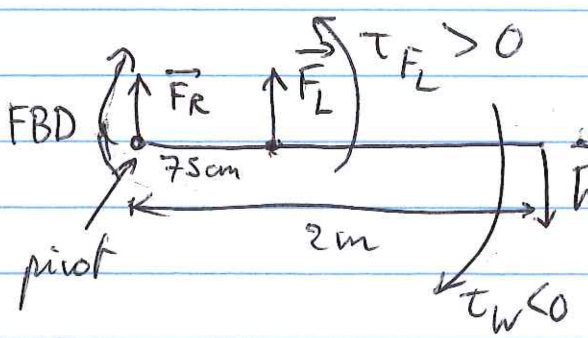


1) what is the value for F_R?

2) what is the value of F_L?

$\tau_{net} = 0$ and $\vec{F}_{net} = 0$ (only vertical)

FBD



$$\begin{cases} F_{net} = 0 = F_R + F_L - \underline{W} = 0 \\ \tau^R_{net} = 0 = \cancel{\tau_{F_R}}^{\,0} + \underline{\tau_{F_L}} + \tau_W \end{cases}$$

$$0 = (0.75m)\,\underline{F_L} - (2m)Mg$$

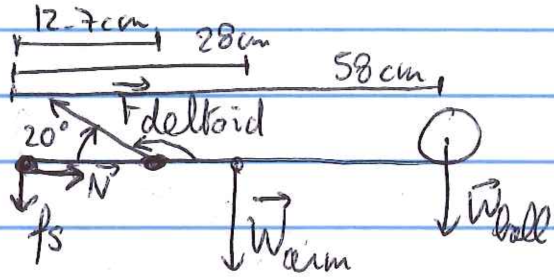
$$\hookrightarrow F_L = \frac{2m}{0.75m} Mg = 131N$$

$$F_R = W - F_L = Mg - (131\,N) = \underline{-82\,N}$$

pivot in L: $\tau^{L}_{net} = 0 = -(0.75m)F_R - (1.25m)Mg$

$$\hookrightarrow F_R = -\frac{1.25m}{0.75m} Mg = -82\,N$$

FBD



$m_{ball} = 2.25\,kg$

$m_{arm} = 3.15\,kg$

1) what is the force $F_{deltoid}$?

2) what is the magnitude & direction of $\vec{f_s}$ and $\vec{N}$?

1) $\tau^{N}_{net} = F_{deltoid}\sin(180° - 20°)\cdot(12.7cm) - (28cm)\,\underline{W_{arm}} - (58cm)\,\underline{W_{ball}} = 0$

$F_{deltoid} = 781\,N$ $\qquad W_{arm} = 31\,N$

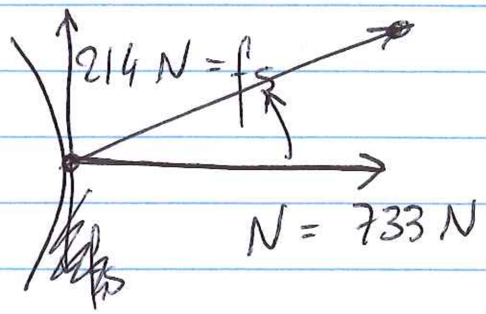
$\qquad\qquad\qquad\qquad W_{ball} = 22\,N$

2) horizontal: $F_{net,x} = N - F_{deltoid}\cos 20° = 0$

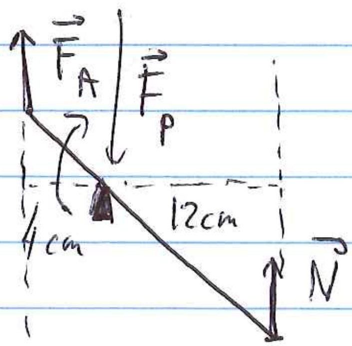
$$\hookrightarrow N = F_{deltoid}\cos 20° = 733\,N$$

vertical: $F_{net,y} = -f_s + \underline{F_{deltoid}\sin 20°} - W_{arm} - \underline{W_{ball}} = 0$

$$\hookrightarrow f_s = -214\,N$$



$\vec{F}_{contact} = (733N, 214N)$



$\vec{N} = mg \quad , \; m = 75\,kg \rightarrow N = 750N$

$\tau = r_\perp F$

1) what is F_A ?

2) what is F_p ?

1) $\tau^{p}_{net} = -\overset{r_\perp}{(4cm)}\, F_A + (12cm)\, N$

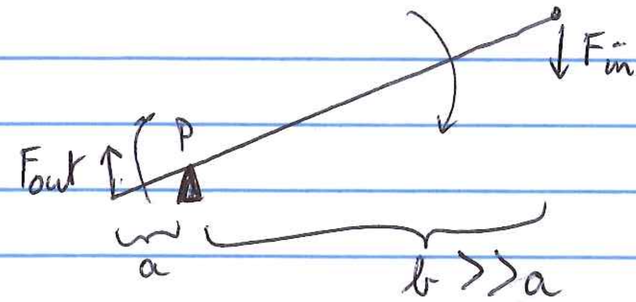
$\hookrightarrow \; \underline{F_A} = \frac{12cm}{4cm}(75\,kg)(9.8\,m/s^2) = \overline{2205N}$

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \shortparallel$
3x weight

2) $F_{net,y} = F_A - F_p + N = 0$

$\hookrightarrow \; F_p = F_A + N = 4 \times \text{weight}$

Mechanical advantage: $\frac{F_{out}}{F_{in}} : \frac{W}{F_A = 3x\ \text{weight}} = \frac{1}{3}$



$\tau^{P}_{net} = 0 \quad \rightarrow \quad MA = \frac{b}{a} >> 1$