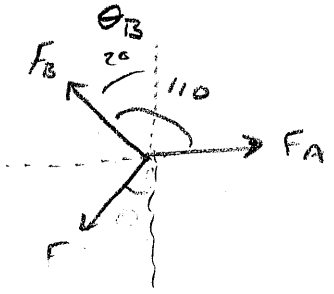
P247 1-10, 13, 15-20, 26-28

(1)



x

$\Sigma F = 0$

$F_A - F_B \sin\theta_B - F_{Cx} = 0$

$F_{Cx} = F_A - F_B \sin\theta_B$

$= 310 - 425 \sin 20$

$= 164.64$ (left)

y

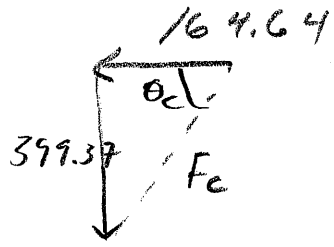
$\Sigma F = 0$

$F_B \cos 20 - F_{Cy} = 0$

$F_{Cy} = F_B \cos 20$

$= 425 \cos 20$

$= 399.37$ (down)



$F_C = \sqrt{(164.64)^2 + (399.37)^2}$

$= 431.97$

$\tan\theta_C = \frac{399.37}{164.64}$

$\theta_C = 67.59°$

$? = 180 - 67.59$

∴ using angle in diagram.

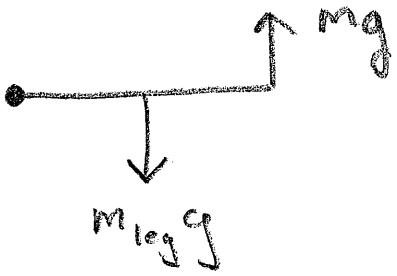
430 N 112°

(2) $\tau = Fr$

$= mgr$

$= 58(9.8)3$

$= 1700\ N$ clockwise.



(3)

$m_{leg}g$

$\tau_{cw} = \tau_{ccw}$

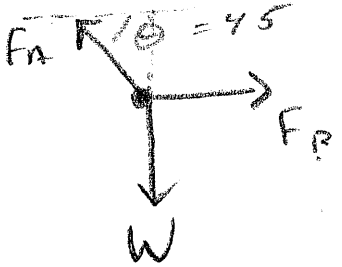
$m_{leg}g r_1 = mg r_2$

$m = \frac{m_{leg} r_1}{r_2} = \frac{15(.35)}{.805} = \underline{6.52\ kg}$

(4) $\tau = Fr$

$r = \frac{\tau}{F} = \frac{1100}{(58)(9.8)} = \underline{1.9\ m}$

(5)



$\sum F = 0$

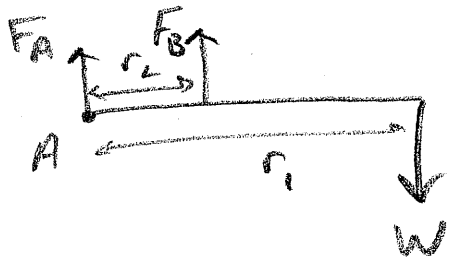
$F_n \sin\theta - W = 0$

$W = F_n \sin\theta$

$= 1550 \sin 45$

$= \underline{1100\ N}$

(6)(a)



Pivot @ A

$\tau_{cw} = \tau_{ccw}$

$W r_1 = F_B r_2$

$F_B = \frac{mg r_1}{r_2}$

$= \frac{58(9.8)(4)}{1}$

$= 2273.6$

$\Sigma F = 0$

$F_A + F_B - W = 0$

$F_A = W - F_B$

$= mg - F_B$

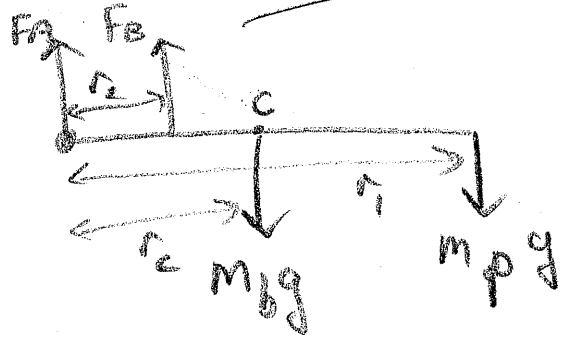
$= 58(9.8) - 2273.6$

$= -1705.2$

$F_A = 1700\,N$ DOWN

$F_B = 2300\,N$ UP

(b)



Pivot @ A

$\tau_{cw} = \tau_{ccw}$

$m_b g r_c + m_p g r_1 = F_B r_2$

$F_B = \frac{35(9.8)2 + 58(9.8)(4)}{1}$

$= 2959.6$

$\Sigma F = 0$

$F_A + F_B - m_b g - m_p g = 0$

$F_A = m_b g + m_a g - F_B$

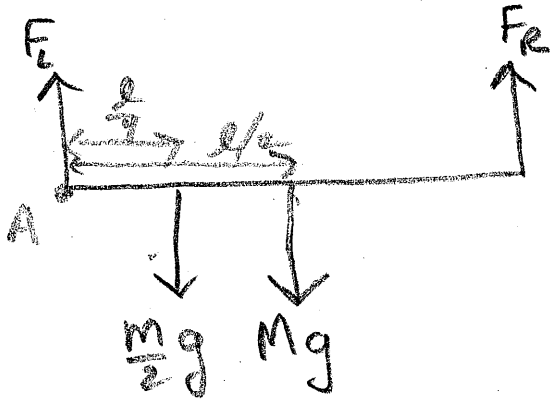
$= 35(9.8) + 58(9.8) - 2959$

$= -2047$

$F_A = 2000\,N$ DOWN

$F_B = 3000\,N$ UP

(7)



Pivot @ A

$\Sigma \tau = 0$

$$\frac{m}{2}g\frac{l}{4} + mg\frac{l}{2} - F_R l = 0$$

$$F_R = \frac{mg}{8} + \frac{4mg}{8} = \frac{5mg}{8} = \frac{5(940)(9.8)}{8}$$

$$F_R = 5757.5 = \underline{5800\ N}$$

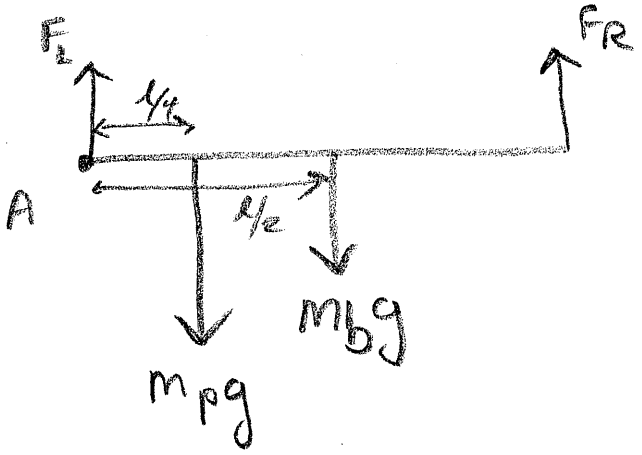
$\Sigma F = 0$

$$F_L + F_R - \frac{mg}{2} - mg = 0$$

$$F_L = \frac{3mg}{2} - F_R = \frac{3(940)(9.8)}{2} - 5757.5$$

$$F_L = 8060.5 = \underline{8100\ N}$$

(8)



Rotate about point A

$$\Sigma \tau = 0$$

$$m_p g \frac{\ell}{4} + m_b g \frac{\ell}{2} - F_R \ell = 0$$

$$F_R = \frac{m_p g}{4} + \frac{m_b g}{2} = \frac{320(9.8)}{4} + \frac{140(9.8)}{2}$$

$$F_R = 1470 = \underline{1500\ N} \text{ down}$$

$$\Sigma F = 0$$

$$F_L + F_R - m_p g - m_b g = 0$$

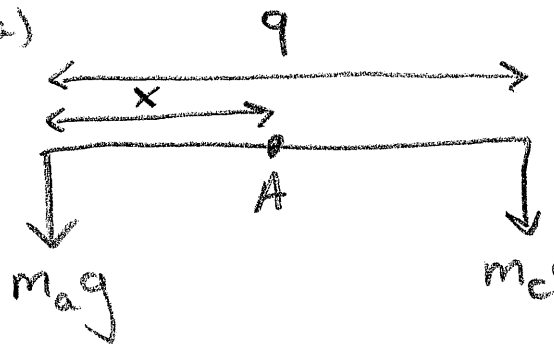
$$F_L = m_p g + m_b g - F_R$$

$$= 320(9.8) + 140(9.8) - 1470$$

$$F_L = 3038 = \underline{3000\ N} \text{ down}$$

* The force <u>on</u> the supports is down, the supports exert an upward force.

(9) (a)



Pivot @ A

$\Sigma \tau = 0$

$-m_a g x + m_c g(9 - x) = 0$

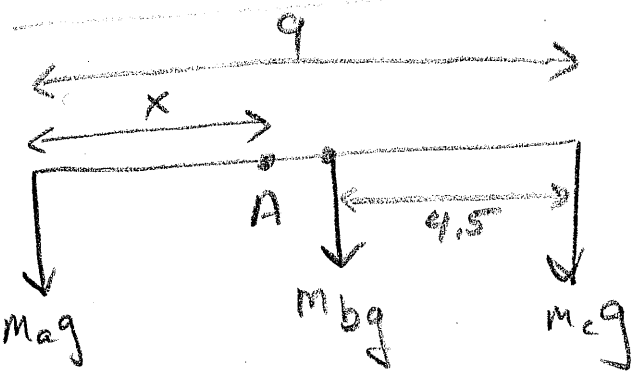
$-m_a x + 9m_c - m_c x$

$(m_a + m_c)x = 9m_c$

$x = \dfrac{9m_c}{m_a + m_c} = \dfrac{9(25)}{75+25} = 2.25\ m$

2.3 m from the adult

(b)



Pivot @ A

$\Sigma \tau = 0$

$-m_a g x + m_b g(4.5 - x) + m_c g(9 - x) = 0$

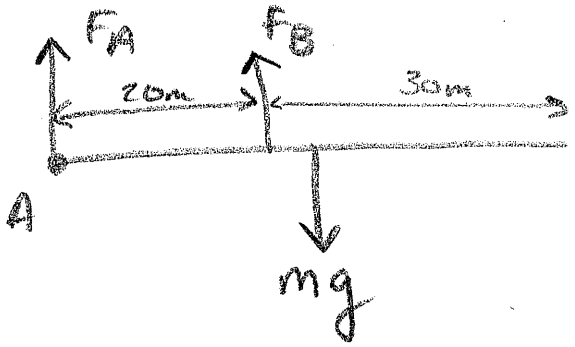
$-m_a x + 4.5 m_b - m_b x + 9m_c - m_c x = 0$

$(m_a + m_b + m_c)x = 4.5 m_b + 9m_c$

$x = \dfrac{4.5(15) + 9(25)}{75 + 15 + 25} = 2.54$

2.5 m from adult

(12)



Pivot @ A

$\Sigma \tau = 0$

$-F_B(20) + mg(25) = 0$

$F_B = \frac{mg\,25}{20} = \frac{1200(9.8)\,25}{20} = 14700 = 15000\,N$ up

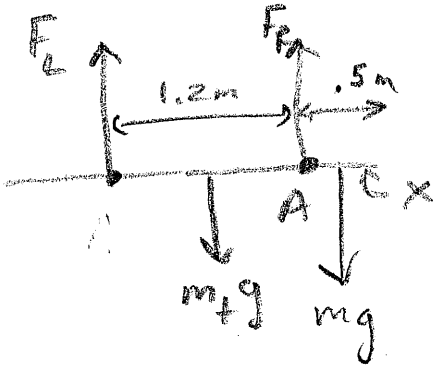
$\Sigma F = 0$

$F_A + F_B - mg = 0$

$F_A = mg - F_B = 1200(9.8) - 14700 = -2940$

$= 2900N$ Down

(13)



Pivot @ A

"At verge of tipping"

$F_L = 0$

$\Sigma \tau = 0$

$-.6 m_t g + mg(.5 - x) = 0$

$-.6 m_t + .5m - mx = 0$

$x = \frac{-.6 m_t + .5m}{m} = \frac{-.6(20) + .5(66)}{66}$

$x = 0.32\ m$

(15) Pivot @ A

$\Sigma \tau = 0$

$4300(2) + 3100(6) + 2200(9) + 250(9.8)(5) - F_B(10) = 0$

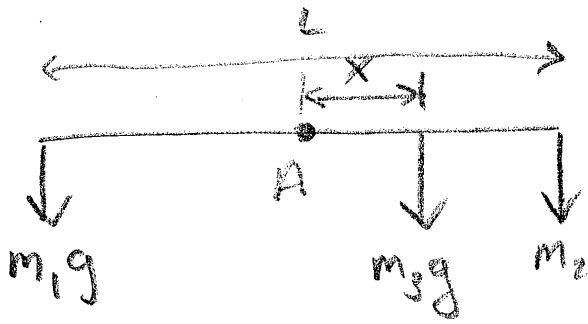
$F_B = 5925 = \underline{5900\ N}$

$\Sigma F = ma$

$F_A + F_B - 4300 - 3100 - 2200 - 250(9.8) = 0$

$F_A = 6125 = \underline{6100\ N}$

(16)



Pivot @ A

$\Sigma \tau = 0$

$-m_1 g \frac{L}{2} + m_3 g x + m_2 g \frac{L}{2} = 0$

$x = \frac{(m_1 - m_2)\frac{L}{2}}{m_3} = \frac{(50-35)\frac{3.6}{2}}{25} = 1.08$

$x = \underline{1.1\ m}$

(17) $F_T = F_B$ pivot at P

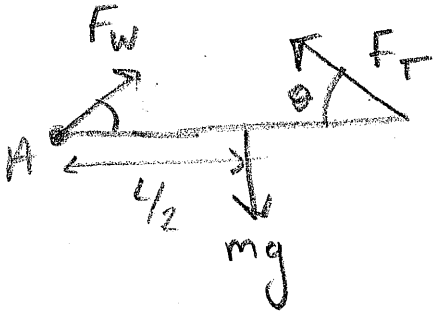
force on both sides of forceps equal.

$\Sigma \tau = 0$ use one half only.

$F_B r_B - F_{rod} r = 0$

$F_{rod} = \frac{F_B r_B}{r} = \frac{11(.085)}{.027} = \underline{34.6\ N}$

(18) (a)



Length of rod = L

pivot at A

$\Sigma \tau = 0$

$\frac{mgL}{2} - F_T L \sin\theta = 0$

$F_T = \frac{mg}{2\sin\theta} = \frac{27(9.8)}{2\sin 40} = 205.8 = \underline{210\ N}$

(b)

$\Sigma F = 0$ (x)

$F_{Wx} - F_T \cos\theta = 0$

$F_{Wx} = F_T \cos\theta$

$= 205.8(\cos 40)$

$= 157.669$

$\Sigma F = 0$ (y)

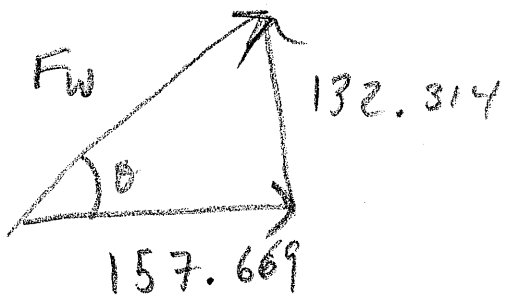
$F_{Wy} - mg + F_T \sin\theta = 0$

$F_{Wy} = mg - F_T \sin\theta$

$= 27(9.8) - 205.8\sin 40$

$= 132.314$

18 (b)



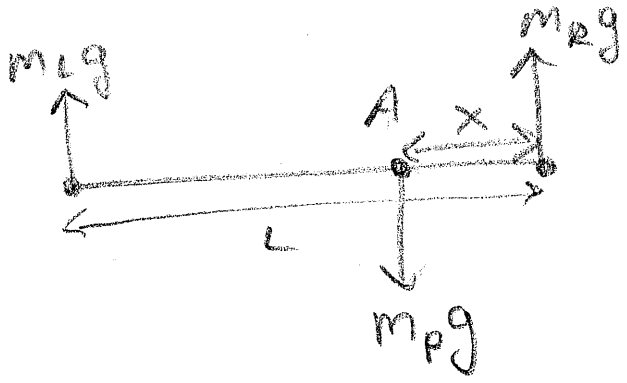
$$F_w = \sqrt{157.669^2 + 132.314^2}$$

$$= 205.8\ N$$

$$\theta = \tan^{-1}\left(\frac{132.314}{157.669}\right) = 40^\circ$$

$F_w = 210\ N$ 40° above the horizontal.

(19)



Pivot at A because we don't know the person's mass.

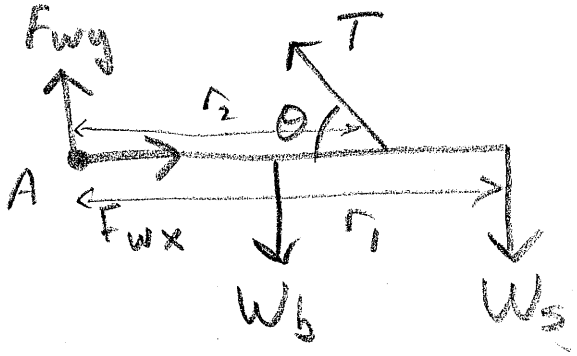
$\Sigma \tau = 0$ Pivot A

$$m_L g(L - x) - m_R g x = 0$$

$$m_L g L - m_L g x - m_R g x = 0$$

$$x = \frac{m_L L}{m_L + m_R} = \frac{(35.1)(1.72)}{(35.1 + 31.6)} = 0.905\ m$$

(20)



$\Sigma \tau = 0$ pivot A

$W_b \frac{r_1}{2} + W_s r_1 - T r_2 \sin\theta = 0$

$$T = \frac{W_b \frac{r_1}{2} + W_s r_1}{r_2 \sin\theta} = \frac{155\left(\frac{1.70}{2}\right) + 245(1.70)}{1.55 \sin 35}$$

$T = 708.0 = \underline{710\ N}$

X

$\Sigma F = 0$

$F_{wx} - T\cos\theta = 0$

$F_{wx} = T\cos\theta$

$= 708 \cos 35$

$F_{wx} = 579.65$

$F_{wx} = \underline{580\ N}$

j

$\Sigma F = 0$

$F_{wy} + T\sin\theta - W_b - W_s = 0$

$F_{wy} = W_b + W_s - T\sin\theta$

$= 155 + 245 - 708 \sin 35$

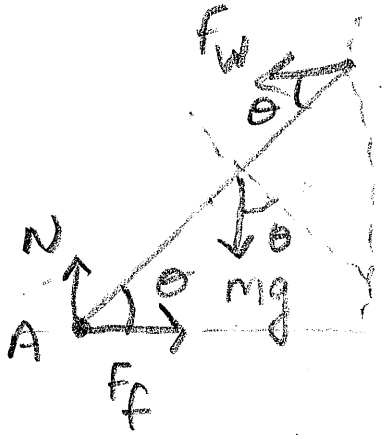
$= -6.09$

$F_{wy} = \underline{-6.1\ N}$

or

$\underline{6.1\ N\ down}$

(26)



$F_f = \mu N$ ← y direction

↑ x direction

$\Sigma \tau = 0$ About at A

$$-F_w \ell \sin\theta + mg\frac{\ell}{2}\cos\theta = 0$$

$$F_w = \frac{mg\cos\theta}{2\sin\theta} = \frac{mg}{2\tan\theta}$$

x

$\Sigma F = 0$

$-F_f + f_w = 0$

$F_f = F_w = \frac{mg}{2\tan\theta}$

y

$\Sigma F = 0$

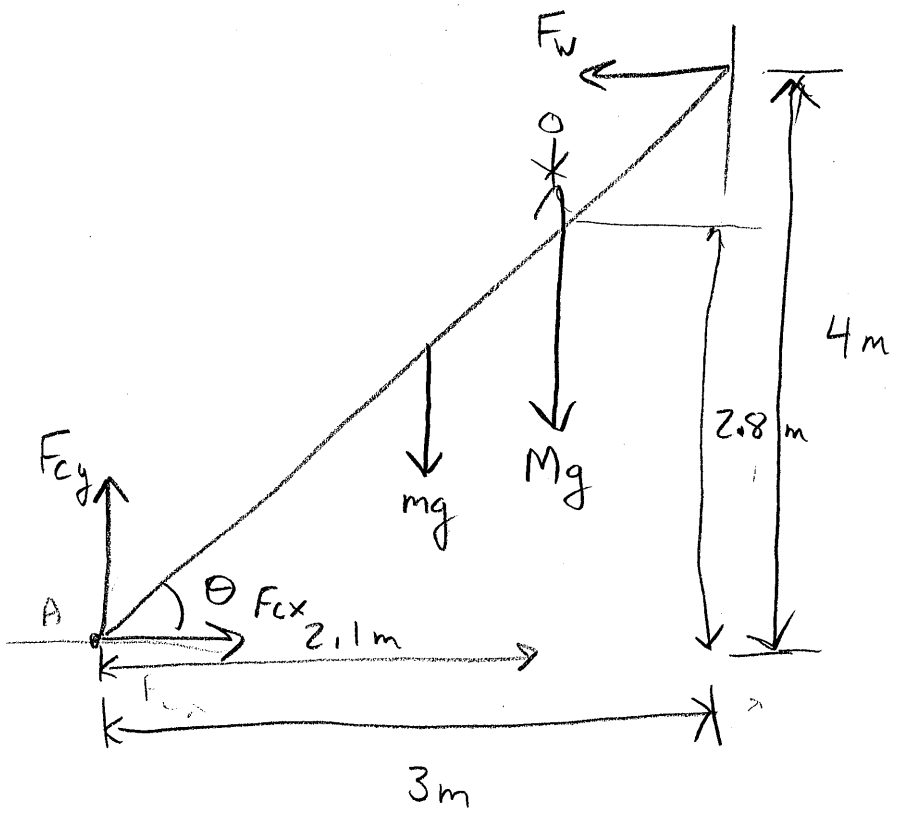
$N - mg = 0$

$N = mg$

$$\mu = \frac{F_f}{N} = \frac{mg}{2\tan\theta}\left(\frac{1}{mg}\right)$$

$$2\tan\theta = \frac{1}{2\mu}$$

(27)



$\Sigma \tau = 0$ about A

$mg(1.5) + Mg(2.1) = F_w(4)$

$F_w = \frac{mg(1.5) + Mg(2.1)}{4} = \frac{12(9.8)(1.5) + 55(9.8)(2.1)}{4} = 327.075$

$\Sigma F = 0$

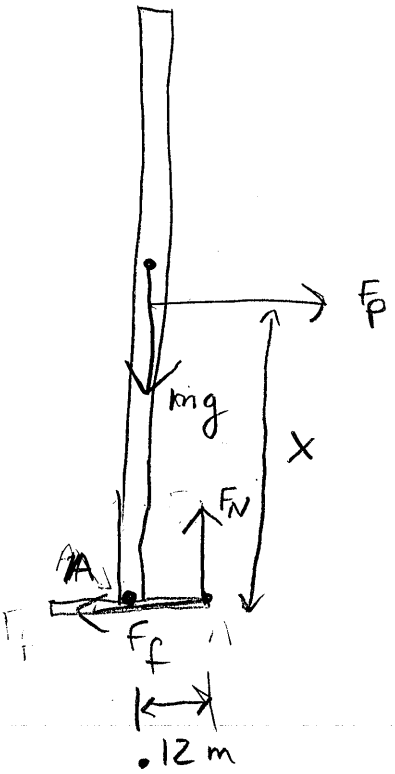
x: $F_{cx} = F_w = 327.075 = F_f = \mu F_w = \mu F_{cy}$

y: $F_{cy} = mg + Mg = 12(9.8) + 55(9.8) = 656.6$

$327.075 = \mu(656.6)$

$\mu = 0.498$

(28)



Just at the point of tipping
F_N at edge of base
keep in equilibrium

$\Sigma \tau = 0$ about A

$F_N(.12) = F_p X$

$\Sigma F = 0$

x: $F_f = F_p = \mu F_N$

y: $F_N = mg$

$mg(.12) = \mu mg X$

$X = \frac{.12}{\mu} = \frac{.12}{.2} = \underline{0.6 \text{ m}}$