HW 9

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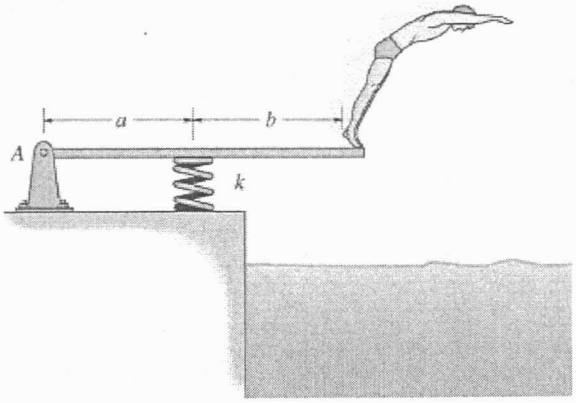
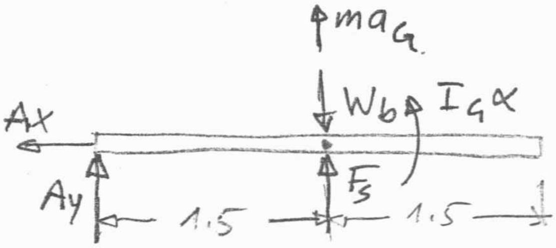
1772

Question 3: (25 Points)

Determine the angular acceleration of the 25-kg diving board and the horizontal and vertical components of reaction at the pin *A* the instant the man jumps off. Assume that the board is uniform and rigid, and that at the instant he jumps off the spring is compressed a maximum amount of 200mm, when $\omega = 0$, and the board is horizontal. Take $k = 7$ kN/m and $a = b = 1.5$ m.

Use Newton's equation of motion.





$F_s = k\delta = (7000)(0.2)$

$= 1400N$

$W_b = mg = 25(9.81) = 245.25N$

$I_A = \frac{1}{3}ml^2 = 75 \text{ kg m}^2$

$\rightarrow \Sigma F_x = 0 \rightarrow A_x = 0$

$\circlearrowleft \Sigma M_A = I_A\alpha$

$(F_s - W)(1.5) = I_A\alpha$

$(1400 - 245.25)(1.5) = 75\alpha \rightarrow \alpha = 23.095$

$a_G = \alpha r = 23.095(1.5) = 34.6425 \text{ m/s}^2$

$\uparrow \Sigma F_y = ma_G$

$A_y + F_s - W_b = ma_G$

$A_y = ma_G + W_b - F_s$

$= (25)(34.6425) + 245.25 - 1400$

$A_y = -288.69 \text{ N}$

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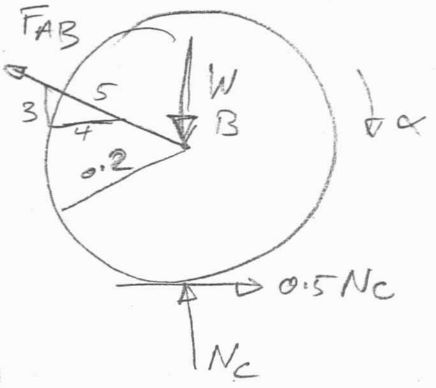
two-force-member

$W = mg = 245.25 N$

$I_B = m k_B^2 = 25(0.15) = 0.5625\ kgm^2$



$\uparrow \Sigma F_y = ma_{Gy}$;

$\frac{3}{5} F_{AB} + N_C - W = 0$ (1)

$\rightarrow \Sigma F_x = ma_{Gx}$: $0.5 N_C - \frac{4}{5} F_{AB} = 0$ (2)

$\circlearrowright \Sigma M_B = I_B \alpha$: $0.5 N_C (0.2) = 0.5625(-\alpha)$ (3)

Solving yields

$F_{AB} = 111.48 N$ $N_C = 178.4 N$ $\alpha = -31.71\ rad/s^2$

$A_x = \frac{4}{5} F_{AB} = 89.2 N$

$A_y = \frac{3}{5} F_{AB} = 66.9$

$\omega = \omega_0 + \alpha_c t$

$0 = 40 + (-31.71) t$

$\hookrightarrow t = 1.26 s$

17-90

$$I_G = m k_G^2 = \frac{100000}{9.81}(7)^2 = 499490 \ kg\, m^2$$

$$\Sigma M_G = I_G \alpha$$

$$T(0.5) = 499490\, \alpha$$

$$\hookrightarrow \alpha = \frac{250000(0.5)}{499490} = 0.25 \ rad/s^2$$

$$\vec{\alpha} = 0.25 \vec{k}$$

$$\uparrow: \Sigma F = m a_G$$

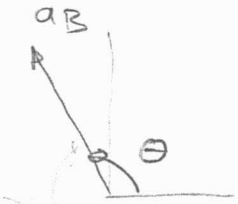
$$T - W = \frac{W}{g} a_G \Rightarrow a_G = \frac{-100+250}{100}(9.81) = 14.72 \ m/s^2$$

$$\vec{a}_G = 14.72 \vec{j}$$

$$\vec{a}_B = \vec{a}_G + \vec{\alpha} \times \vec{r}_{B/G} - \omega^2 \vec{r}_{B/G}$$ initial acceleration, $\rightarrow \omega = 0$

$$= 14.72\vec{j} + (0.25)\vec{k} \times 10\vec{j} - 0$$

$$\vec{a}_B = -2.5\vec{i} + 14.72\vec{j}$$



$$a_B = \sqrt{(-2.5)^2 + (14.72)^2} = 14.93 \ m/s^2$$

$$\theta = \tan^{-1}\frac{14.72}{-2.5} = 99.51°$$

HW7-1

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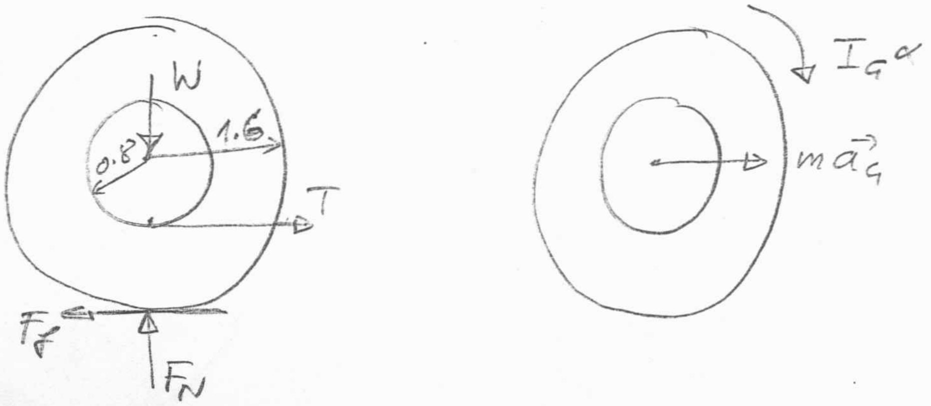


greatest acceleration $= F_f = \mu_s F_N$ $\qquad \mu_s = 0.5$

$I_G = m k_G^2 = 500(1.3)^2 = 845 \text{ kg m}^2$

initial α and $T \rightarrow \omega_0 = 0$

$\Sigma F_x = m a_G: \quad T - F_f = 500 a_G \qquad (1)$

$\Sigma F_y = 0: \quad F_N - W = 0 \quad \Rightarrow F_N = W = 4905 \text{ N}$

$F_f = 2452.5 \text{ N}$

$a_G = 0.8\,\alpha \qquad (2)$

$\curvearrowright \Sigma M_G = I_G \alpha: \quad F_f(1.6) - 0.8T = 845\,\alpha \qquad (3)$

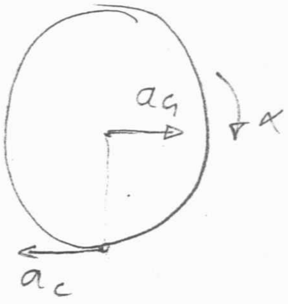
(1), (2) + (3) yields

$\alpha = 1.684 \text{ rad/s} \qquad a_G = 1.347 \text{ m/s}^2 \qquad T = 3126.15\text{N}$

$\vec{a}_c = \vec{a}_G + \vec{\alpha} \times \vec{r}_{c/G} - \cancel{\omega^2 \vec{r}_{c/G}} \rightarrow 0$

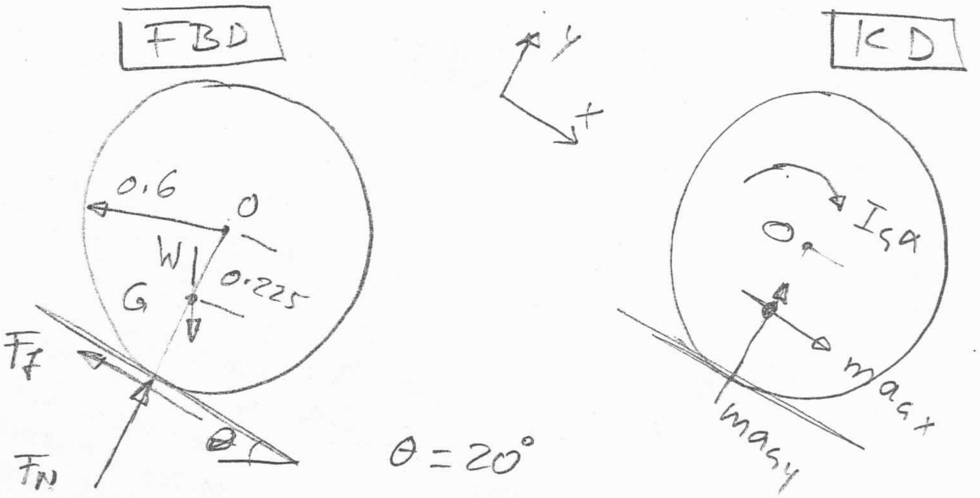
$= 1.347\vec{i} - 1.684\vec{k} \times (-1.6\vec{j})$

$= 1.347\vec{i} - 2.6944\vec{i}$



$\vec{a}_c = -1.3474\,\vec{i}$

$\underline{17-107}$ $\quad m = \frac{900}{9.81} = 91.74\ kg \quad\quad k_G = 0.5m$



$$\nearrow \Sigma F_y = ma_{Gy} : F_N - W\cos\theta = ma_{Gy} \quad (1)$$

$$\searrow \Sigma F_x = ma_{Gx} : -F_f + W\sin\theta = ma_{Gx} \quad (2)$$

$$\curvearrowright \Sigma M_G = I_G\alpha : (0.6 - 0.225) F_f = mk_G^2\alpha \quad (3)$$

$$\vec{a}_O = \alpha r \vec{i} = 0.6\alpha\vec{i} \quad (4)$$

$$\vec{a}_G = \vec{a}_O + \vec{\alpha} \times \vec{r}_{G/O} - \omega^2 \vec{r}_{G/O}$$

$$= 0.6\alpha\vec{i} - \alpha\vec{k} \times (-0.225\vec{j}) - (6)^2(-0.225\vec{j})$$

$$= 0.375\alpha\vec{i} + 8.1\vec{j} \quad (5)$$

$\hookrightarrow a_{Gx} = 0.375\alpha \quad\quad a_{Gy} = 8.1\ m/s^2$

(1): $F_N - 900\cos 20 = \frac{900}{9.81}(8.1) \Rightarrow \boxed{F_N = 1588.817N}$

(3): $\alpha = \frac{0.375}{mk_G^2} F_f \quad (6)$

(6) into (2) and solving yields

$$\boxed{F_f = 197N}$$