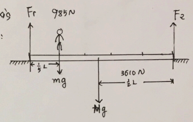
Homework 9

Yang Hu

13. Since the bridge is equilibrium. the torque should be 0. Also, the net force on y-axis should be 0. Therefore: at right-most point:



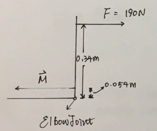
$$\Sigma\tau = -F_1 L + mg\left(\tfrac{4}{5}L\right) + Mg\left(\tfrac{1}{2}L\right)$$
$$= 0$$

$$F_1 = \tfrac{4}{5}mg + \tfrac{1}{2}Mg = 2590N$$

$$\Sigma F_y = F_1 + F_2 - mg - Mg = 0$$

$$F_2 = -F_1 + mg + Mg = 2010N$$

15.



Since in this case, the system is equilibrium, the $\Sigma\tau$ should be 0. Because there're only 2 forces. these 2 torques are equal and opposite:

$$\tau_F = Fl = (190N)(0.34m) = 64.6\ Nm$$

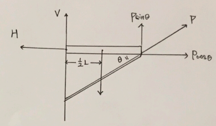
$$|\tau_{\vec{M}}| = \tau_F = 64.6\ Nm = (|\vec{M}|)(0.054m)$$

$$|\vec{M}| = 1196.3\ N$$

$$I = F_{net}\,\Delta t$$
$$= \Delta PE$$
$$= mv_f - mv_i$$

total moment of Inertia $I = \Sigma mr^2$

21. Since the system is equilibrium, the $\Sigma\tau$ and ΣF_x are all zeros.



At the left-most point of the beam:

$$V * 0 + W\left(\tfrac{1}{2}L\right) - P\sin\theta * L = 0$$

$$\frac{W}{2} = P\sin\theta$$

$$P = \frac{W}{2\sin\theta} = 270.13N$$

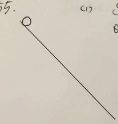
Also, on horizontal direction:

$$P\cos\theta - H = 0$$
$$H = P\cos\theta = 209.93\ N$$

Therefore, on vertical direction:

$$V + P\sin\theta = W$$
$$V = W - P\sin\theta = 170N$$

55.



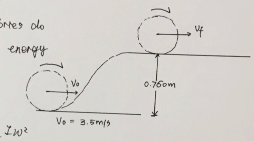
(1) Since no non-conservative forces do works. the mechanical energy conserves, which means:

$$\tfrac{1}{2}mv_0^2 + mgh_0 = \tfrac{1}{2}mv_f^2 + mgh_f + \tfrac{1}{2}I\omega^2$$
$$mgh_0 = \tfrac{1}{2}mv_f^2 + \tfrac{1}{2}I\omega^2$$
$$= \tfrac{1}{2}mv_f^2 + \tfrac{1}{2}\left(\tfrac{2}{3}mr^2\right)\left(\tfrac{V^2}{r^2}\right)$$
$$= \tfrac{1}{2}mv_f^2 + \tfrac{1}{2}m\,\tfrac{2}{3}v_f^2$$
$$gh_0 = \tfrac{1}{2}v_f^2 + \tfrac{1}{3}v_f^2$$
$$v_f = \sqrt{\frac{6gh}{5}},\quad h = \frac{\frac{5}{6}v_f^2}{g} = 3.704m$$

(2) Since the Inertia of a solid cylinder is $\frac{1}{2}MR^2$

$$mgh_0 = \tfrac{1}{2}mv_f^2 + \tfrac{1}{2}\left(\tfrac{1}{2}Mr^2\right)\left(\tfrac{V^2}{r^2}\right)$$
$$gh_0 = \tfrac{1}{2}v_f^2 + \tfrac{1}{4}v_f^2$$
$$v_f = \sqrt{\frac{4gh}{3}} = 6.957\ m/s$$

57. Since no non-conservative forces do the work. the total mechanical energy conserves.



$$E_0 = E_f$$

Because $E = \frac{1}{2}mv^2 + mgh + \frac{1}{2}I\omega^2$

and $I(\text{solid sphere}) = \frac{2}{5}mr^2$

$$\tfrac{1}{2}mv_0^2 + mgh_0 + \tfrac{1}{2}\left(\tfrac{2}{5}mr^2\right)\left(\tfrac{V_0}{r}\right)^2 = \tfrac{1}{2}mv_f^2 + mgh_f + \tfrac{1}{2}\left(\tfrac{2}{5}mr^2\right)\left(\tfrac{v_f}{r}\right)^2$$

$$\tfrac{7}{10}V_0^2 + gh_0 = \tfrac{7}{10}V_f^2 + gh_f$$

$$V_f^2 = V_0^2 - \tfrac{10}{7}g(h_f - h_i)$$

Therefore. $V_f = \sqrt{(3.5m/s)^2 - \frac{10}{7}(9.8m/s^2)(0.760m)}$

$= 1.267\ m/s$