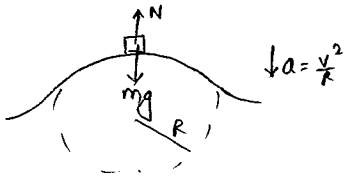
Solutions to Midterm Exam 03 (Summer 2015, 203A)

MT03, prob. 1

$$a_c = \frac{4\pi^2 R}{T^2} = \frac{4\pi^2 \times 6.38\times 10^6 m}{(24\times 60\times 60\ s)^2} = 3.37\times 10^{-2}\ \frac{m}{s^2}.$$

MT03, prob. 2



$$N - mg = -m\frac{v^2}{R}$$

$$N = mg - \frac{mv^2}{R}$$

$N = 0$ (for maximum speed) $\Rightarrow$ $mg = m\frac{v^2}{R}$

$$v = \sqrt{gR} = \sqrt{9.8\times 60} = 24.3\ \frac{m}{s}.$$

MT03, prob. 3

(a) $W_g = mg\,d\,\cos 90 = 0$

(b) $W_N = N\,d\,\cos 90 = 0$

(c) $W_{pull} = F_{pull}\,d\,\cos\theta = 75.0\times 10.0\times \cos 30 = 649.5\ J$

(d) $W_{fric} = F_f\,d\,\cos 180 = -F_f\,d$

$$= -\mu_k N d$$

$$= -\mu_k (mg + F_{pull}\sin\theta)\,d$$

$$= -0.30\,(30.0\times 9.8 + 75.0\times \sin 30.0)\,10.0 = -995\ J$$

MT03, prob. 4

$$K_A + U_A = K_E + U_E$$

$$\frac{1}{2}m v_A^2 + mg h_A = \frac{1}{2}m v_E^2 + mg h_E$$

$$0 + g h_A = \frac{1}{2} v_E^2 + g h_E$$

$$v_E = \sqrt{2g(h_A - h_E)} = \sqrt{2\times 9.8\times (50.0 - 20.0)}$$

$$= 24.3\ \frac{m}{s}$$

MT03, prob. 5

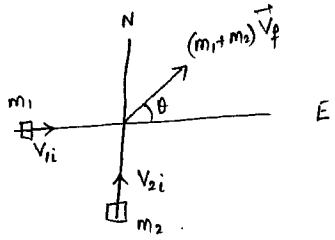
$$K_i + U_i = K_f + U_f$$

$$0 + mgh = \frac{1}{2}mv_f^2 + 0$$

$$v_f = \sqrt{2gh} = \sqrt{2\times 9.8\times 1.2} = 4.85\ \frac{m}{s}$$

$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t} = \frac{\vec{p}_f - \vec{p}_i}{\Delta t} = \frac{0 - [-75.0\times 4.85]\hat{j}}{75.0\times 10^{-3}\ s} = 4850\,\hat{j}\ N$$

MT03, prob. 6



$$(m_1+m_2)\vec{v}_f = m_1 v_{1i}\hat{i} + m_2 v_{2i}\hat{j}$$

$$8500\,\vec{v}_f = 2500\times 20.0\,\hat{i} + 6000\times 25\,\hat{j}$$

$$\vec{v}_f = 5.88\ \frac{m}{s}\,\hat{i} + 17.7\ \frac{m}{s}\,\hat{j}$$

$$|\vec{v}_f| = \sqrt{5.88^2 + 17.7^2} = 18.7\ \frac{m}{s}$$

$$\theta = \tan^{-1}\left(\frac{17.7}{5.88}\right) = 71.6\ \text{N of E}$$

MT03, prob. 7

(a) $\cancel{K_i^{=0}} + U_i = K_f + \cancel{U_f^{=0}} \Rightarrow v = \sqrt{2gh} = \sqrt{2\times 9.8\times 1.00} = 4.43\ \frac{m}{s}$

(b) $$v_{2f} = \frac{2m_2}{m_1+m_2}v_{1i} = \frac{2\times 2.50}{(1.50+2.50)}\times 4.43\ \frac{m}{s} = +5.54\ \frac{m}{s}$$

MT03, prob. 8

$$(m_J+m_B)x_{cm} = m_J x_J + m_B x_B$$

$$(80+50)\times 10.0 = 80.0\times 15.0 + 50.0\,x_B$$

$$1300 = 1200 + 50.0\,x_B$$

$$x_B = 2.00\ m$$