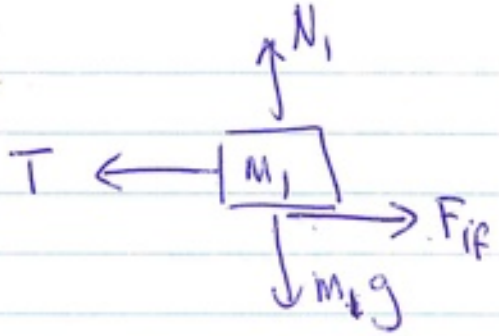
Example

top:



$$\sum F_y = N_1 - m_1 g = 0$$

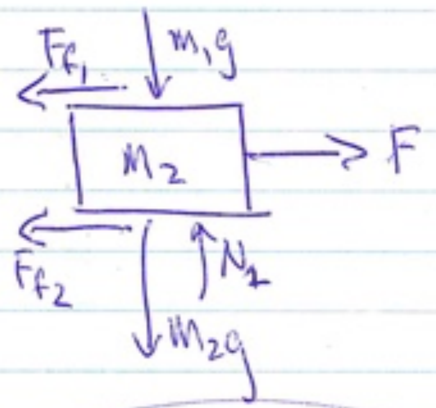
$$\therefore N_1 = m_1 g$$

$$F_{f_1} = \mu_k N_1$$

$$= \mu_k m_1 g = (0.1)(5\,kg) \times 9.8\,m/s^2$$

$$= 4.9\,N$$

bottom:



$$\sum F_y = N_2 - m_1 g - m_2 g = 0$$

$$\therefore N_2 = (m_1 + m_2) g$$

$$\sum F_x = F - F_{f_1} - F_{f_2} = m_2 a$$

$$F_{f_2} = \mu_k N_2 = \mu_k (m_1 + m_2) g$$

$$= (0.1)(15\,kg)(9.8\,\frac{m}{s^2})$$

$$= 14.7\,N$$

$$\therefore a = \frac{1}{10\,kg}\left(30N - 4.9N - 14.7N\right)$$

$$= 1.04\,\frac{m}{s^2}$$

11.12 E is conserved.

$K_i = 0 \quad U_i = mgh \quad (U = 0 \text{ at } y = 0)$

$E = K_i + U_i = mgh$

$K_f = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 \qquad U_f = mg(2R)$

$(v = \omega b)$

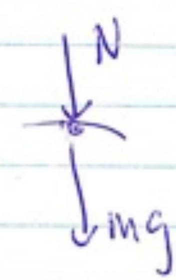
$I = \beta m b^2 \qquad \beta = \frac{2}{5}$

$\therefore K_f = \frac{1}{2}mv^2(1+\beta)$

$\therefore \frac{1}{2}\cancel{m}v^2(1+\beta) + \cancel{m}g \cdot 2R = \cancel{m}gh$

$\therefore \frac{1}{2}v^2(1+\beta) + 2gR = gh$

free-body diagram



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

$N = 0 \Rightarrow mg = m\frac{v^2}{R} \Rightarrow v^2 = gR$

$$\frac{1}{2}(\cancel{g}R)(1+\beta) + 2\cancel{g}R = \cancel{g}h$$

$$h = R\left(\frac{1}{2}(1+\beta) + 2\right)$$

$$= (0.14\,m)\left[\frac{1}{2}\left(1+\frac{2}{5}\right) + 2\right]$$

$$= (0.14\,m)\underbrace{\left[0.7 + 2\right]}_{2.7}$$

$$= 0.378\ m.$$

11.39 (a) $\tau_{avg} = \frac{\Delta L}{\Delta t}$

$= \frac{(0.8 - 3.0)\,kg\cdot m^2/s}{1.50\,s}$

$= -1.47\ N\cdot m$

(b) $\tau = I\alpha \qquad L_i = I\omega_i$

$\alpha = \frac{-1.47\ kg\cdot m^2/s^2}{0.140\,kg\,m^2} = -10.5\ rad/s^2$

$\omega_i = \frac{3.0\ kg\cdot m^2/s}{0.140\ kg\cdot m^2} = 21.4\ \frac{rad}{s}$

$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2 \qquad \left(\text{cf. } \Delta x = v_i t + \frac{1}{2}at^2\right)$

$= 21.4\,\frac{rad}{s} \times 1.50\,s + \frac{1}{2}\left(-10.5\,\frac{rad}{s^2}\right)(1.5\,s)^2$

$= 20.4\ rad$

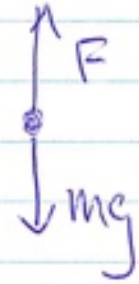
(c) $W = \tau\Delta\theta = (-1.47\ N\cdot m)(20.4\ rad)$

$= -30\ J.$

(d) $P = \frac{-W}{\Delta t} = \frac{30\ J}{1.5\,s} = 20\ W.$

289 #8 $\quad F = -k\Delta y$

$(\Delta y = -0.06\,m)$



$F = mg$

$\therefore -k\Delta y = mg \quad \therefore k = \dfrac{mg}{-\Delta y}$

$= \dfrac{3\,kg \times 9.8\,m/s^2}{-(-0.06\,m)}$

$= 490\,\frac{N}{m}.$

$W_s = -\Delta U$

$= -\frac{1}{2}k\left(y_f^2 - y_i^2\right)$

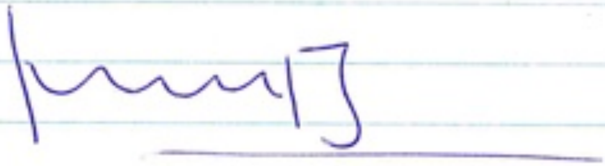
$y_i = -0.06\ m$

$y_f = -0.16\ m$

$W_s = -\frac{1}{2} \cdot 490\,\frac{N}{m}\left((0.16m)^2 - (0.06m)^2\right)$

$= -5.4\,J.$

2012 #14



$k = 80 \frac{N}{m}$.

E is conserved.

$E = \frac{1}{2} m v^2 + \frac{1}{2} k x^2$ $\quad x$: displacement from $eq^{\underline{m}}$.

$x = 0.04$ m.

$v = 0.5$ m/s.

$$\frac{1}{2} m v_{max}^2 = \frac{1}{2} m v^2 + \frac{1}{2} k x^2$$

$$v_{max}^2 = v^2 + \frac{k}{m} x^2$$

$$= \left(0.5 \frac{m}{s}\right)^2 + \left(\frac{80\ N/m}{0.5\ kg}\right)(0.04 m)$$

$$= 0.25 \frac{m^2}{s^2} + 0.256 \frac{m^2}{s^2}$$

$$v = 0.71 \frac{m}{s}$$