# SOLUTIONS TO ASSIGNMENT 4 2004

1

Serway 6.9 $\quad v_t = \sqrt{\dfrac{2mg}{D\rho A}}$

For a golf ball $\quad v_{t_g} = \sqrt{\dfrac{2 m_g g}{D_g \rho A_g}}$

For a baseball $\quad v_{t_b} = \sqrt{\dfrac{2 m_b g}{D_b \rho A_b}}$

$$\frac{v_{tb}}{v_{tg}} = \sqrt{\frac{\cancel{2} m_b \cancel{g}}{\cancel{D_b} \rho A_b} \; \frac{\cancel{D_g} \rho A_g}{\cancel{2} m_g \cancel{g}}}$$

But we assumed $D_g = D_b$

From Table 6.1 $\quad \dfrac{v_{tb}}{v_{tg}} = \sqrt{\dfrac{m_b \; A_g}{A_b \; m_g}} = \sqrt{\dfrac{0.145 \times 1.4 \times 10^{-3}}{0.046 \times 4.2 \times 10^{-3}}} = \sqrt{1.0507}$

$$\frac{v_{tb}}{v_{tg}} = 1.03$$

This means that the terminal velocity for the baseball is larger than the terminal velocity for the golf ball

But from Table 6.1 the terminal velocity for a golf ball is greater than for a baseball which is the opposite of what we have calculated.

This means that our assumption that the drag coefficients were the same for golf balls and baseballs is incorrect.

Both are spheres but the dimpled surface of the golf ball reduces the drag by preventing turbulence. That is, the drag coefficient is less for a golf ball than for a baseball.

**P6.40**

2

$$\sum F = ma$$

$$-kmv^2 = m\frac{dv}{dt}$$

$$-kdt = \frac{dv}{v^2}$$

$$-k\int_0^t dt = \int_{v_0}^{v} v^{-2}dv$$

$$-k(t-0) = \left.\frac{v^{-1}}{-1}\right|_{v_0}^{v} = -\frac{1}{v}+\frac{1}{v_0}$$

$$\frac{1}{v} = \frac{1}{v_0}+kt = \frac{1+v_0kt}{v_0}$$

$$v = \frac{v_0}{1+v_0kt}$$

***P6.41** (a) From Problem 40,

3

$$v = \frac{dx}{dt} = \frac{v_0}{1+v_0kt}$$

$$\int_0^x dx = \int_0^t v_0\frac{dt}{1+v_0kt} = \frac{1}{k}\int_0^t \frac{v_0kdt}{1+v_0kt}$$

$$x\Big|_0^x = \frac{1}{k}\ln(1+v_0kt)\Big|_0^t$$

$$x-0 = \frac{1}{k}\left[\ln(1+v_0kt)-\ln 1\right]$$

$$\boxed{x = \frac{1}{k}\ln(1+v_0kt)}$$

(b) We have $\ln(1+v_0kt) = kx$.

$1+v_0kt = e^{kx}$ so $v = \dfrac{v_0}{1+v_0kt} = \dfrac{v_0}{e^{kx}} = \boxed{v_0e^{-kx} = v}$

**P6.60** For the block to remain stationary, $\sum F_y = 0$ and $\sum F_x = ma_r$.

4

$$n_1 = (m_p + m_b)g \text{ so } f \le \mu_{s1} n_1 = \mu_{s1}(m_p + m_b)g.$$

At the point of slipping, the required centripetal force equals the maximum friction force:

$$\therefore (m_p + m_b)\frac{v_{\max}^2}{r} = \mu_{s1}(m_p + m_b)g$$

or $v_{\max} = \sqrt{\mu_{s1} r g} = \sqrt{(0.750)(0.120)(9.80)} = 0.939$ m/s.

For the penny to remain stationary on the block:

$$\sum F_y = 0 \Rightarrow n_2 - m_p g = 0 \text{ or } n_2 = m_p g$$

and $\sum F_x = ma_r \Rightarrow f_p = m_p \dfrac{v^2}{r}$.

When the penny is about to slip on the block, $f_p = f_{p,\max} = \mu_{s2} n_2$

or $\mu_{s2} m_p g = m_p \dfrac{v_{\max}^2}{r}$

$$v_{\max} = \sqrt{\mu_{s2} r g} = \sqrt{(0.520)(0.120)(9.80)} = 0.782 \text{ m/s}$$

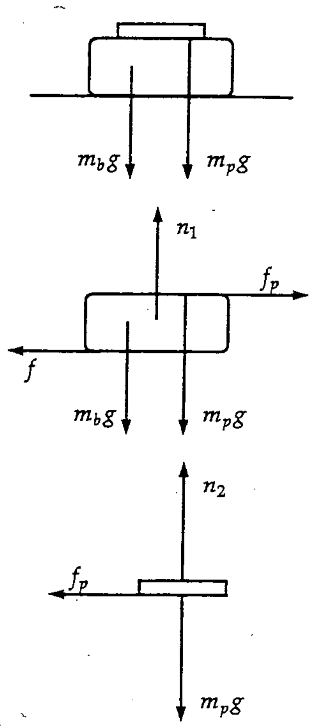

**FIG. P6.60**

This is less than the maximum speed for the block, so the penny slips before the block starts to slip The maximum rotation frequency is

$$\text{Max rpm} = \frac{v_{\max}}{2\pi r} = (0.782 \text{ m/s})\left[\frac{1 \text{ rev}}{2\pi(0.120 \text{ m})}\right]\left(\frac{60 \text{ s}}{1 \text{ min}}\right) = \boxed{62.2 \text{ rev/min}}.$$