Problem 13.50 (Page 122)

Block A has a mass of $m_A$ and is attached to a spring having a stiffness of $k$ with an unstretched length of $l_0$. If another block B, having a mass of $m_B$, is pressed against A so that the spring deforms a distance $d$, show that for separation to occur, it is necessary that $d^2 > 2\mu_k g(m_A + m_B)/k$. Also determine the distance the two blocks slide on the surface before they separate.

**Block A:**

$$\sum F_x = -k(x - d) - N - \mu_k m_A g = m_A a_x$$

**Block B:**

$$\sum F_x = N - \mu_k m_B g = m_B a_x \quad a_A = a_B$$

$$a = \frac{k(d-x) - \mu_k g (m_A + m_B)}{(m_A + m_B)} = \frac{k(d-x)}{(m_A + m_B)} - \mu_k g$$

$$N = \frac{km_B (d-x)}{(m_A + m_B)} \quad \text{for } N = 0 \quad x = d \quad \text{separation}$$

At the moment of separation:

$$vdv = gdx$$

or

$$\int_0^v vdv = \int_0^d \frac{k(d-x)}{m_A + m_B} dx - \int_0^d \mu_k g dx$$

$$v = \sqrt{\frac{kd^2 - 2\mu_k g (m_A + m_B)}{(m_A + m_B)}} \quad \text{Necessary for } v > 0$$

or

$$kd^2 - 2\mu_k g (m_A + m_B) > 0$$

$$kd > 2\mu_k g(m_A + m_B)$$

or

$$d^2 > 2\mu_k g(m_A + m_B)/k$$
Problem 13.51 (Page 122)

A block A has a mass of \( m_A \) and rests on a pan B, which has a mass of \( m_B \). Both are supported by a spring having a stiffness \( k \) that is attached to the bottom of the pan and to the ground. Determine the distance \( d \) the pan should be pushed down from an equilibrium position and then released so that the separation of the block will take place from the surface of the pan at the instant the spring becomes unstretched.

For equilibrium:

\[
\sum F_y = -(m_A + m_B)g = Y_{eq}k
\]

\[
Y_{eq} = \left( \frac{m_A + m_B}{k} \right) q \quad \text{initial position}
\]

For the block:

\[
\sum F_y = -m_A q + N = m_A a
\]

For block and pan:

\[
\sum F_y = -(m_A + m_B)q + k(Y_{eq} + y) = (m_A + m_B)a
\]

Thus:

\[
-(m_A + m_B)q + k \left[ \left( \frac{m_A + m_B}{k} \right) q + y \right] = (m_A + m_B) \left( \frac{-m_A q + N}{m_A} \right)
\]

For \( y = d \), \( N = 0 \):

\[
k d = -(m_A + m_B)q \quad \text{or} \quad d = \left( \frac{m_A + m_B}{k} \right) q
\]
A sports car, having a mass of 1700 kg, is traveling horizontally along a 20° banked track which is circular with a radius of $\rho = 100$ meters. If the coefficient of static friction between the tires and the road $\mu_s = 0.2$, determine the maximum constant speed at which the car can travel without sliding up the slope.

\[ \sum F_y = N \cos 20° - 0.2 N \sin 20° - 1700 (9.81) = 0 \]

\[ N = 19140.6 \text{ N} \]

\[ \sum F_n = 19140.6 \sin 20° + 0.2 (19140.6) \cos 20° = 1700 \left( \frac{V^2}{100} \right) \]

\[ V = 24.4 \text{ m/sec} \]