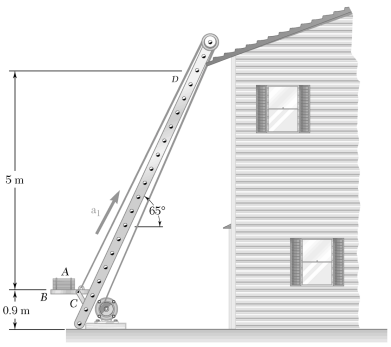
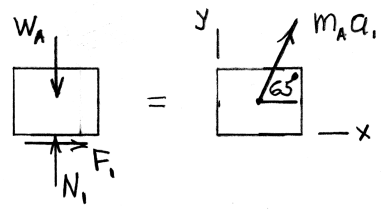


PROBLEM 12.22

To transport a series of bundles of shingles *A* to a roof, a contractor uses a motor-driven lift consisting of a horizontal platform *BC* which rides on rails attached to the sides of a ladder. The lift starts from rest and initially moves with a constant acceleration $\mathbf{a}_1$ as shown. The lift then decelerates at a constant rate $\mathbf{a}_2$ and comes to rest at *D*, near the top of the ladder. Knowing that the coefficient of static friction between the bundle of shingles and the horizontal platform is 0.30, determine the largest allowable acceleration $\mathbf{a}_1$ and the largest allowable deceleration $\mathbf{a}_2$ if the bundle is not to slide on the platform.

SOLUTION

Acceleration $\mathbf{a}_1$: Impending slip. $F_1 = \mu_s N_1 = 0.30\ N_1$



$$+\uparrow \Sigma F_y = m_A a_y: \quad N_1 - W_A = m_A a_1 \sin 65°$$

$$N_1 = W_A + m_A a_1 \sin 65°$$

$$= m_A\left(g + a_1 \sin 65°\right)$$

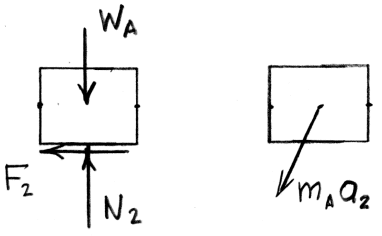
$$\xrightarrow{+} \Sigma F_x = m_A a_x: \quad F_1 = m_A a_1 \cos 65°$$

$$F_1 = \mu_s N \quad \text{or} \quad m_A a_1 \cos 65° = 0.30 m_A\left(g + a_1 \sin 65°\right)$$

$$a_1 = \frac{0.30g}{\cos 65° - 0.30 \sin 65°} = (1.990)(9.81) = 19.53 \text{ m/s}^2$$

$$\mathbf{a}_1 = 19.53 \text{ m/s}^2 \angle 65° \blacktriangleleft$$

Deceleration $\mathbf{a}_2$: Impending slip. $F_2 = \mu_S N_2 = 0.30\ N_2$



$$+\uparrow \Sigma F_y = ma_y: \quad N_1 - W_A = -m_A a_2 \sin 65°$$

$$N_1 = W_A - m_A a_2 \sin 65°$$

$$\xleftarrow{+} \Sigma F_x = ma_x: \quad F_2 = m_A a_2 \cos 65°$$

$$F_2 = \mu_S N_2 \quad \text{or} \quad m_A a_2 \cos 65° = 0.30 m_A\left(g - a_2 \cos 65°\right)$$

$$a_2 = \frac{0.30g}{\cos 65° + 0.30 \sin 65°} = (0.432)(9.81) = 4.24 \text{ m/s}^2$$

$$\mathbf{a}_2 = 4.24 \text{ m/s}^2 \angle 65° \blacktriangleleft$$