8–65. Determine the smallest horizontal force $P$ required to pull out wedge $A$. The crate has a weight of 300 lb and the coefficient of static friction at all contacting surfaces is $\mu_s = 0.3$. Neglect the weight of the wedge.

Free Body Diagram. Since the crate is on the verge of sliding down and the wedge is on the verge of sliding to the left, the frictional force $F_B$ on the crate must act upward and forces $F_C$ and $F_D$ on the wedge must act to the right as indicated on the free-body diagrams as shown in Figs. a and b. Also, $F_B = \mu_s N_B = 0.3 N_B$, $F_C = \mu_s N_C = 0.3 N_C$, and $F_D = \mu_s N_D = 0.3 N_D$.

Equations of Equilibrium. Referring to Fig. a,

\[ \sum F_x = 0; \quad N_B - 0.3 N_C = 0 \]
\[ + \sum F_y = 0; \quad N_C + 0.3 N_B - 300 = 0 \]

Solving,

\[ N_B = 82.57 \text{ lb} \quad N_C = 275.23 \text{ lb} \]

Using the result of $N_C$ and referring to Fig. b, we have

\[ + \sum F_y = 0; \quad N_D \cos 15^\circ + 0.3 N_D \sin 15^\circ - 275.23 = 0 \quad N_D = 263.74 \text{ lb} \]
\[ \sum F_x = 0; \quad 0.3(275.23) + 0.3(263.74) \cos 15^\circ - 263.74 \sin 15^\circ - P = 0 \quad P = 90.7 \text{ lb} \]
8–66. Determine the smallest horizontal force $P$ required to lift the 200-kg crate. The coefficient of static friction at all contacting surfaces is $\mu_s = 0.3$. Neglect the mass of the wedge.

**Free - Body Diagram.** Since the crate is on the verge of sliding up and the wedge is on the verge of sliding to the right, the frictional force $F_A$ on the crate must act downward and forces $F_B$ and $F_C$ on the wedge must act to the left as indicated on the free-body diagrams as shown in Figs. a and b. Also, $F_A = \mu_s N_A = 0.3 N_A$, $F_B = \mu_s N_B = 0.3 N_B$, and $F_C = \mu_s N_C = 0.3 N_C$.

**Equations of Equilibrium.** Referring to Fig. a,

\[ \sum F_x = 0; \quad 0.3 N_B - N_A = 0 \]

\[ \sum F_y = 0; \quad N_B - 0.3 N_A - 200(9.81) = 0 \]

Solving,

\[ N_A = 646.81 \text{ N} \quad N_B = 2156.04 \text{ N} \]

Referring to Fig. b,

\[ \sum F_y = 0; \quad N_C \cos 15^\circ - 0.3 N_C \sin 15^\circ - 2156.04 = 0 \quad N_C = 2427.21 \text{ N} \]

\[ \sum F_x = 0; \quad P - 0.3(2156.04) - 2427.21 \sin 15^\circ - 0.3(2427.21) \cos 15^\circ = 0 \quad P = 1978.37 \text{ N} = 1.98 \text{ N} \]

Ans.
8-71. Determine the smallest horizontal force $P$ required to move the wedge to the right. The coefficient of static friction at all contacting surfaces is $\mu_s = 0.3$. Set $\theta = 15^\circ$ and $F = 400$ N. Neglect the weight of the wedge. $m_s = 0.3 \ u = 15^\circ$

Free Body Diagram. Since the wedge is required to be on the verge of sliding to the right, the frictional forces $F_C$ and $F_D$ on the wedge must act to the left such that $F_C = \mu_s N_C = 0.3 N_C$ and $F_D = \mu_s N_D = 0.3 N_D$.

Equations of Equilibrium. Referring to the free-body diagram of the crank shown in Fig. a,
\[ \sum F_y = 0; \quad 400(0.45) + 0.3 N_C \cos 15^\circ (0.02) + 0.3 N_C \sin 15^\circ (0.3) - N_C \cos 15^\circ (0.3) - N_C \sin 15^\circ (0.02) = 0 \]
\[ N_C = 704.47 \text{ N} \]

Referring to the free-body diagram of the wedge shown in Fig. b,
\[ \sum F_x = 0; \quad N_D + 0.3(704.47) \cos 15^\circ - 704.47 \cos 15^\circ = 0 \]
\[ N_D = 625.76 \text{ N} \]
\[ \sum F_y = 0; \quad P - 0.3(704.47) \cos 15^\circ - 0.3(625.76) - 704.47 \sin 15^\circ = 0 \]
\[ P = 574 \text{ N} \]

Ans.
If the uniform concrete block has a mass of 500 kg, determine the smallest horizontal force \( P \) needed to move the wedge to the left. The coefficient of static friction between the wedge and the concrete and the wedge and the floor is \( \mu_s = 0.3 \). The coefficient of static friction between the concrete and floor is \( \mu_f = 0.5 \).

**Free Body Diagram.** Since the wedge is required to be on the verge of sliding to the left, the frictional forces \( F_B \) and \( F_C \) on the wedge must act to the right such that \( F_B = \mu_s N_B = 0.3 N_B \) and \( F_C = \mu_s N_C = 0.3 N_C \).

**Equations of Equilibrium.** Referring to the free-body diagram of the concrete block shown in Fig. a,

\[
\begin{align*}
\Sigma M_A &= 0; \\
0.3 N_B \cos 75^\circ (0.15) - 0.3 N_B \sin 75^\circ (3) + N_B \cos 75^\circ (3) + N_B \sin 75^\circ (0.15) - 50 \times (981) (1.5) &= 0 \\
N_B &= 2518.78 \text{ N} \\
F_A &= 0.3 (2518.78) \cos 75^\circ - 2518.78 \sin 75^\circ = 0 \\
F_A &= 1077.94 \text{ N} \\
N_A &= 2506.40 \text{ N} \\
0.3 N_C \cos 75^\circ + 0.3 (2518.78) \sin 75^\circ &= 0 \\
N_C &= 2398.60 \text{ N} \\
0.3 N_B &= 0.3 (2518.78) \cos 75^\circ + 2518.78 \sin 75^\circ + 0.3 (2398.60) - P = 0 \quad \text{Ans.}
\end{align*}
\]

Since \( F_A < (F_A)_{\text{max}} = \mu_f N_A = 0.5 \times (2506.40) = 1253.20 \text{ N} \), the concrete block will not slip at \( A \). Using the result of \( N_B \) and referring to the free-body diagram of the wedge shown in Fig. b,

\[
\begin{align*}
\Sigma F_y &= 0; \\
N_C + 0.3 (2518.78) \sin 75^\circ - 2518.78 \cos 75^\circ &= 0 \\
N_C &= 2398.60 \text{ N} \\
\Sigma F_x &= 0; \\
0.3 (2518.78) \cos 75^\circ + 2518.78 \sin 75^\circ + 0.3 (2398.60) - P = 0 \\
P &= 1797.52 \text{ N} = 1.80 \text{ kN} \\
\end{align*}
\]