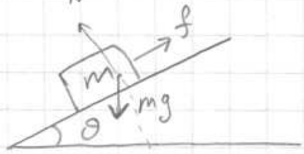
4) חיכוך סטטי ודינאמי:

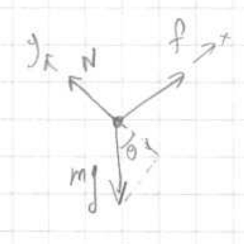
נתונים: $\mu_k = 0.1$ $\mu_s = 0.3$, $m = 5\ kg$



החיכוך הסטטי <u>המקסימלי</u> הינו:

$$f = \mu_s \cdot N$$

הזווית המקסימלית שבה <u>יתכן</u> שיווי-משקל:



בכיוון המישור: $f - mg\sin\theta = 0$

בכיוון ניצב למישור: $N - mg\cos\theta = 0$

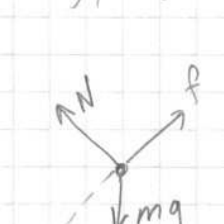
$$N = mg\cos\theta$$

$$f = \mu_s N = \mu_s mg\cos\theta = mg\sin\theta$$ ← מסה לא משפיעה!

$$\tan\theta_{max} = \mu_s$$

$$\theta_{max} = \arctan\mu_s = 16.7^\circ$$

ב. תאוצה עבור זוויות שונות מחושבת ע"י חיכוך קינטי:



$$\begin{cases} mg\sin\theta - f = ma \\ N = mg\cos\theta \end{cases}$$

$$f_k = \mu_k \cdot N = \mu_k mg\cos\theta$$

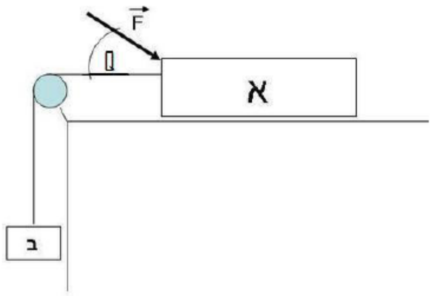
$$mg\sin\theta - \mu_k mg\cos\theta = ma$$

$$a = g[\sin\theta - \mu_k\cos\theta]$$ ← לשים לב ליחידות

$$a(\theta = 45^\circ) = g \cdot \frac{\sqrt{2}}{2}(1 - 0.1) = 6.24\ m/s^2$$

$$a(\theta = 60^\circ) = g\left[\frac{\sqrt{3}}{2} - 0.1 \cdot \frac{1}{2}\right] \approx 8\ m/s^2$$

Solution, Prob. 1 3201



a. Choosing the positive direction of the *x* axis to the left, we have for mass A:

$$\sum F_x^{(A)} = 0 = m_B g - F\cos\theta + f_s$$

Notice that the static friction was selected as positive. Its direction is actually determined by the competition between the other forces in the problem, such that-

$$\boxed{f_s = F\cos\theta - m_B g}$$

may be positive (friction pointing to the left) or negative (friction pointing to the right).

b. We now demand that the friction is indeed in the static regime:

$$-\mu N \le F\cos\theta - m_B g \le \mu N$$

$$\boxed{\frac{m_B + \mu m_A}{\cos\theta - \mu\cos\theta} g \ge F \ge \frac{m_B - \mu m_A}{\cos\theta + \mu\cos\theta} g}$$

Where here we substituted $N = m_A g + F\sin\theta$ from the *y* axis equation.

CHECK UNITS AND LIMITING CASES!!

c. We now consider the case where $F = 0$. Newton's law states:

$$\sum F_x^{(A)} = m_A a = m_B g - f_k$$

$$\boxed{a = \left(\frac{m_B}{m_A} - \mu\right) g}$$

Where here we substituted $f_k = \mu m_A g$.

Forces on *m*:

$$\begin{cases} \sum F_x^{(m)} = ma = F - f_s - mg\sin\alpha \\ \sum F_y^{(m)} = 0 = N_{m-M} - mg\cos\alpha \end{cases}$$

Forces on *M*:

$$\begin{cases} \sum F_x^{(M)} = Ma = f_s - f_k - Mg\sin\alpha \\ \sum F_y^{(M)} = 0 = N_{surface} - N_{m-M} - Mg\cos\alpha \end{cases}$$

And in addition it is known that $f_k = \mu_k N_{surface}$. Solve for f_s and demand the condition $f_s \le \mu_s N_{m-M}$ to get-

$$\boxed{F \le F_{\max} = \left(\frac{m}{M} + 1\right) mg\cos\alpha\left(\mu_s - \mu_k\right)}$$