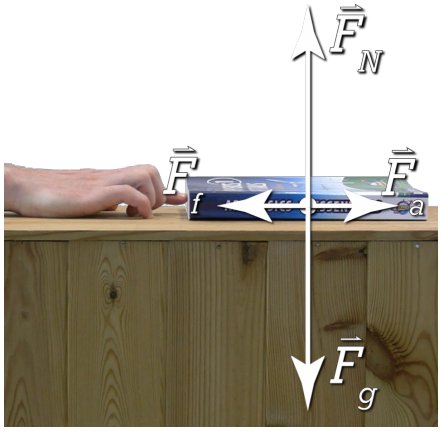
Flipping Physics Lecture Notes:
Does the Book Move?
An Introductory Friction Problem

Example Problem: You apply a horizontal force of 2.0 Newtons to a book with a mass of 0.674 kg. The values for the coefficients of friction between the book and the incline are $\mu_s = 0.27$ and $\mu_k = 0.24$.
(a) Does the book move? (b) What is the acceleration of the book?



$$F_a = 2.0N\left(horizontal\right);\ m = 0.674kg;\ \mu_s = 0.27;\ \mu_k = 0.24;$$

(a) Does the book move?

(b) a = ?

$$\sum F_y = F_N - F_g = ma_y = m\left(0\right) = 0 \Rightarrow F_N = F_g = mg$$

$$\sum F_x = F_a - F_f = ma_x \Rightarrow F_a - F_{sf_{\max}} = ma_x \Rightarrow F_a - \mu_s F_N = ma_x \Rightarrow F_a - \mu_s mg = ma_x$$

$$\Rightarrow 2 - \left(0.27\right)\left(0.674\right)\left(9.81\right) = \left(0.674\right)a_x \Rightarrow 2 - 1.7852 = 0.674a_x$$

(a) Because the net force in the x-direciton is positive, the book will move to the right.

(b) Now that the book is moving, the friction is no longer static, it is kinetic.

$$\sum F_x = F_a - F_f = ma_x \Rightarrow F_a - F_{kf} = F_a - \mu_k F_N = F_a - \mu_k mg = ma_x \Rightarrow a_x = \frac{F_a - \mu_k mg}{m}$$

$$\Rightarrow a_x = \frac{2 - \left(0.24\right)\left(0.674\right)\left(9.81\right)}{0.674} = 0.61296 \approx \boxed{0.61\frac{m}{s^2}}$$