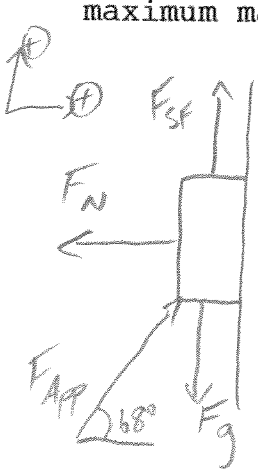
Physics 10154 - Exam #2c

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A person tries to hold a book in place against a vertical wall with an applied force of 130 Newtons directed 68° above the horizontal. If the coefficient of static friction between the book and the wall is 0.44, what is the maximum mass of the book?



Since this is a threshold problem, book will move if more mass added, $F_{SF} = F_{SF,MAX} = \mu_s F_N$

$\Sigma F_x: F_{App}\cos 68° - F_N = 0$

$130 \cos 68° = F_N$

$F_N = 48.7\,N$

$\Sigma F_y: F_{App}\sin 68° + F_{SF} - F_g = 0$

$F_{App}\sin 68° + \mu_s F_N - mg = 0$

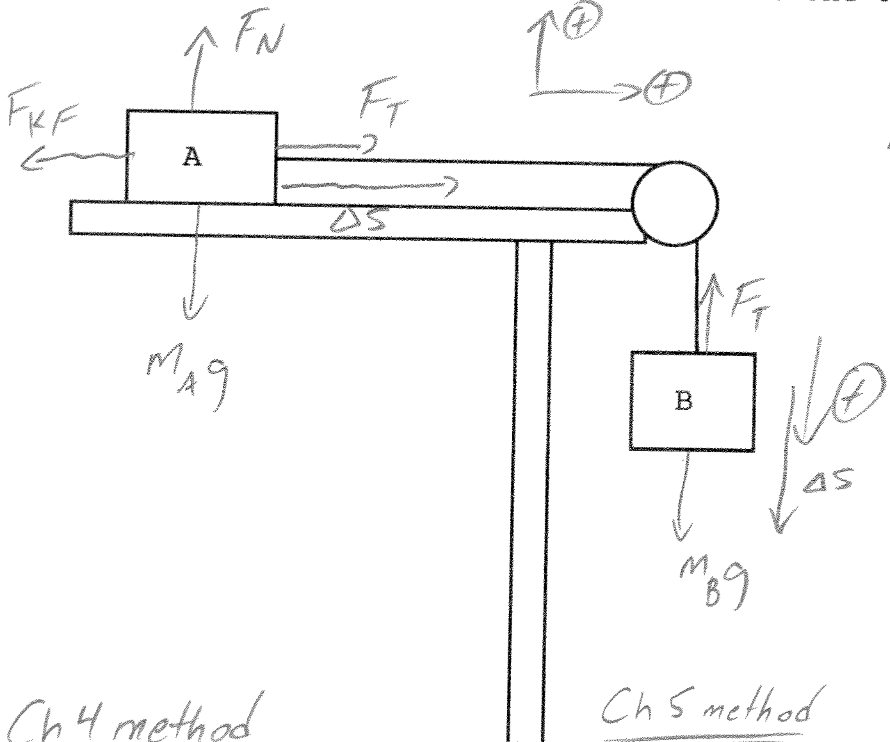
$130 \sin 68° + (0.44)(48.7) - m(9.8) = 0$

$120.5 + 21.4 - m(9.8) = 0$

$141.9 = 9.8m$

$m = 14\,kg$

2. (35 pts) Block A has a mass of 5.0 kg. Block B has a mass of 2.2 kg. The system below is set into motion, and block B falls 65 cm in 1.5 seconds. What is the coefficient of kinetic friction between block A and the horizontal table?



$A: \Sigma F_y: F_N - m_A g = 0$

$F_N = m_A g$

$F_N = 49 N$

$\Delta s = 0.65 m$

$v_0 = 0$

$v = ?$

$a = ?$

$t = 1.5 s$

Ch 4 method

$\Delta s = v_0 t + \frac{1}{2} a t^2$

$0.65 = 0 + \frac{1}{2} a (1.5)^2$

$a = 0.578 \ m/s^2$

$A: \Sigma F_x: F_T - F_{KF} = m_A a$

$F_T - \mu_k F_N = m_A a$

$B: \Sigma F_y: m_B g - F_T = m_B a$

or $F_T = m_B g - m_B a$

$F_T - \mu_k F_N = m_A a$

$m_B g - m_B a - \mu_k F_N = m_a a$

$m_B g - \mu_k F_N = (m_A + m_B) a$

$21.56 - \mu_k (49) = 4.16$

$\mu_k = \frac{17.4}{49} = 0.36$

Ch 5 method

$\Delta s = \frac{1}{2}(v + v_0) t$

$0.65 = \frac{1}{2} v (1.5) \quad v = 0.87 \ m/s$

$W_N = 0$

$W_{grav,A} = 0$

$W_{KF} = \mu_k F_N \Delta s \cos 180°$

$= -\mu_k (49)(0.65) = -31.85 \mu_k$

$W_{T,A} = F_T \Delta s$

$W_{T,B} = -F_T \Delta s$

$W_{grav,B} = m_B g \Delta s = 14.0$

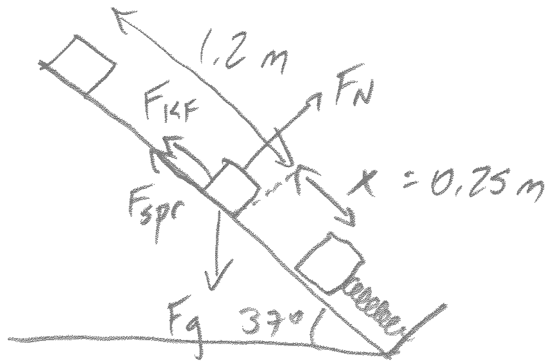
$\Delta K = \frac{1}{2} m_{Tot} v^2 - 0 = \frac{1}{2}(7.2)(.87)^2 = 2.7 J$

$0 + 0 - 31.85 \mu_k + F_T \Delta s - F_T \Delta s + 14 = 2.7$

$-31.85 \mu_k = -11.3$

$\mu_k = 0.36$

3. (35 pts) Starting from rest, a 5.0 kg mass slides 1.2 meters down a rough 37° incline, where it compresses a spring that is oriented parallel to the incline. The maximum compression of the spring is 0.25 meters (so the mass travels a total distance of 1.45 meters on the incline), and the spring constant is 1200 N/m. How much work is done by kinetic friction during this motion?



$W_N = 0$

$W_{grav} = mgh = mg\Delta s \sin 37^\circ$

$= (5.0)(9.8)(1.45)\sin 37^\circ = 42.76\ J$

$W_{spr} = -\frac{1}{2}kx^2 = -\frac{1}{2}(1200)(.25)^2 = -37.5\ J$

$W_{KF} = ?$

$\Delta K = 0$ (starts + ends at rest)

$W_N + W_{grav} + W_{spr} + W_{KF} = \Delta K$

$0 + 42.76 - 37.50 + W_{KF} = 0$

$W_{KF} = -5.3\ J$