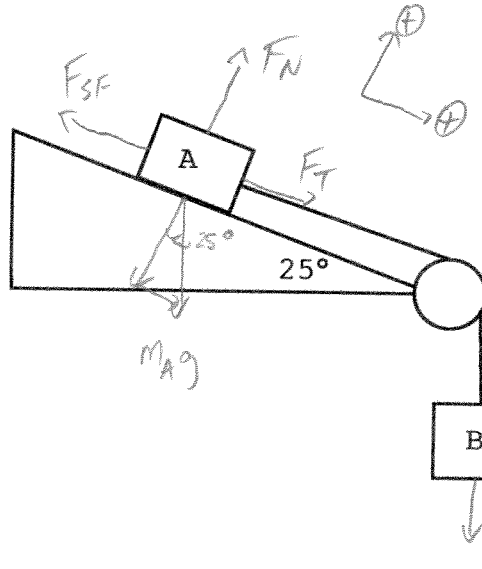
Physics 10154 - Exam #2b

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) Block A has a mass of 12 kg, and it is at rest on a 25° sloped ramp. Block A is connected to block B by a thin string as shown below. The coefficient of static friction between block A and the surface is 0.64. What is the maximum mass of block B for which block A would remain at rest?



$A: \Sigma F_\perp = F_N - m_A g \cos 25° = 0$ (I.)

$\Sigma F_{\parallel} = F_T + m_A g \sin 25° - F_{SF} = 0$

Since this is a threshold problem, $F_{SF} = F_{SF,MAX} = \mu_s F_N$

$F_T + m_A g \sin 25° - \mu_s F_N = 0$ (II.)

$B: \Sigma F_y : m_B g - F_T = 0$ (III.)

From (I.), $F_N = m_A g \cos 25°$

From (III.), $F_T = m_B g$

Eq II is $F_T + m_A g \sin 25° - \mu_s F_N = 0$

$m_B g + m_A g \sin 25° - \mu_s m_A g \cos 25° = 0$

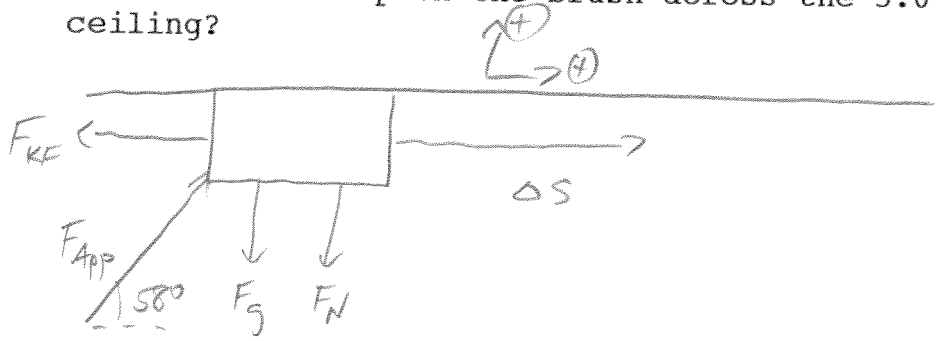
$m_B(9.8) + (12)(9.8)\sin 25° - (1.64)(12)(9.8)\cos 25° = 0$

$m_B(9.8) + 49.7 - 68.2 = 0$

$m_B(9.8) = 18.5$

$m_B = 1.9\ kg$

2. (35 pts) A maintenance worker is trying to push a 3.0 kg cleaning brush across a rough horizontal ceiling by pushing with an applied force of 55 Newtons directed 58° above the horizontal. If the brush is initially at rest and the coefficient of kinetic friction between the brush and ceiling is 0.22, how many seconds does it take to push the brush across the 5.0 meter wide ceiling?



Ch 4 method:

$\Sigma F_y: F_{App}\sin 58° - F_g - F_N = 0$

$(55)\sin 58° - (3)(9.8) - F_N = 0$

$F_N = 17.2\ N$

$\Sigma F_x: F_{App}\cos 58° - F_{KF} = ma$

$(55)\cos 58° - (0.22)(17.2) = 3a$

$29.15 - 3.78 = 3a$

$a = 8.46\ m/s^2$

$\Delta s = 5.0\ m$

$v_0 = 0$

$v = ?$

$a = 8.46\ m/s^2$

$t = ?$

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

$5.0 = 0 + \frac{1}{2}(8.46)t^2$

$1.18 = t^2$

$t = 1.1\ s$

Ch 5 method

$W_g = 0$

$W_N = 0$

$W_{App} = F_{App}\,\Delta s\cos 58°$

$= (55)(5)\cos 58°$

$= 145.7\ J$

$W_{KF} = F_{KF}\,\Delta s\cos 180°$

$= -\mu_K F_N\, 5$

$= -(.22)(17.2)(5)$

$= -18.9\ J$

$\Sigma W_F = 0 + 0 + 145.7 - 18.9 = \Delta K$

$126.8 = \frac{1}{2}(3)v^2 - 0$

$v = 9.19\ m/s$

$\Delta s = 5.0$

$v_0 = 0$

$v = 9.19$

$a = ?$

$t = ?$

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

$5.0 = \frac{1}{2}(9.19)t$

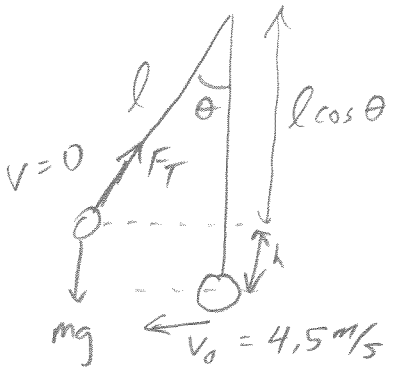
$t = 1.1\ s$

3. (35 pts) A 25-kg child plays on a swing that acts as a pendulum with a length of 3.3 meters. At the lowest point in the motion, the child is moving with a speed of 4.5 m/s.

a) To what maximum height above the lowest point does the child rise as he swings, assuming no frictional forces?

b) What angle does the swing make with the vertical at that maximum height?

c) Suppose there are frictional forces, and the child only rises to a height that is only 85% of your answer for part (a). In this case, how much work is done by friction?



a) $W_T = 0$ F_T always $\perp$ to Δs.

$W_g = -mgh$

$W_T + W_g = \Delta K$

$0 - mgh = 0 - \frac{1}{2}mv_0^2$

$h = \frac{v_0^2}{2g} = 1.03\ m$

or (1.0 m)

b) $h = l - l\cos\theta$

$1.03 = 3.3 - 3.3\cos\theta$

$-2.27 = -3.3\cos\theta$

$0.687 = \cos\theta$

($\theta = 47°$)

c) $h = (0.85)(1.03) = 0.8755$

$W_T = 0$

$W_g = -mgh = -(25)(9.8)(.8755) = -214.5\ J$

$W_{KF} = ?$

$0 - 214.5 + W_{KF} = 0 - \frac{1}{2}mv_0^2$

$-214.5 + W_{KF} = -253.1$

$W_{KF} = -253.1 + 214.5$

$= (-39\ J)$