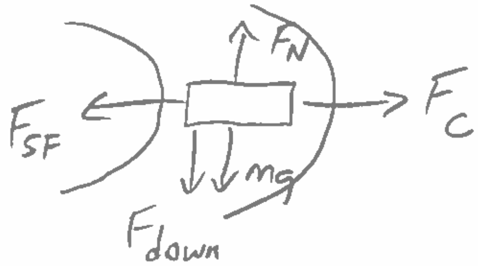
Physics 10154 - Fall 2018 Exam #2B

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) A "wing" attachment on the back of a racing car interacts with the air to provide a "downforce" on the car that gets greater as the car's speed increases. A 1700-kg car rounds a curve (with a radius of curvature of 170 meters) on a flat round with a speed of 93 miles/hour, and the downward force on the car due to the wing is 8500 N.

a) What is the magnitude and direction of the force of static friction acting on the car to keep it from sliding off the track?

b) Assuming the downward force remains the same, the maximum speed with which the car can navigate the curve without slipping is 103 miles/hour. What is the coefficient of static friction between the car and the track? (Answer with 2 SF).



$$\Sigma F_{rad} = \frac{mv^2}{r} - F_{SF} = 0$$

$$V = 93\ \frac{mi}{hr} = 41.566\ m/s$$

$$\frac{mv^2}{r} = \frac{(1700)(41.566)^2}{170} = 17300\ N$$

$$F_{SF} = \frac{mv^2}{r} = \boxed{17000\ N,\ \text{radially inward}}$$

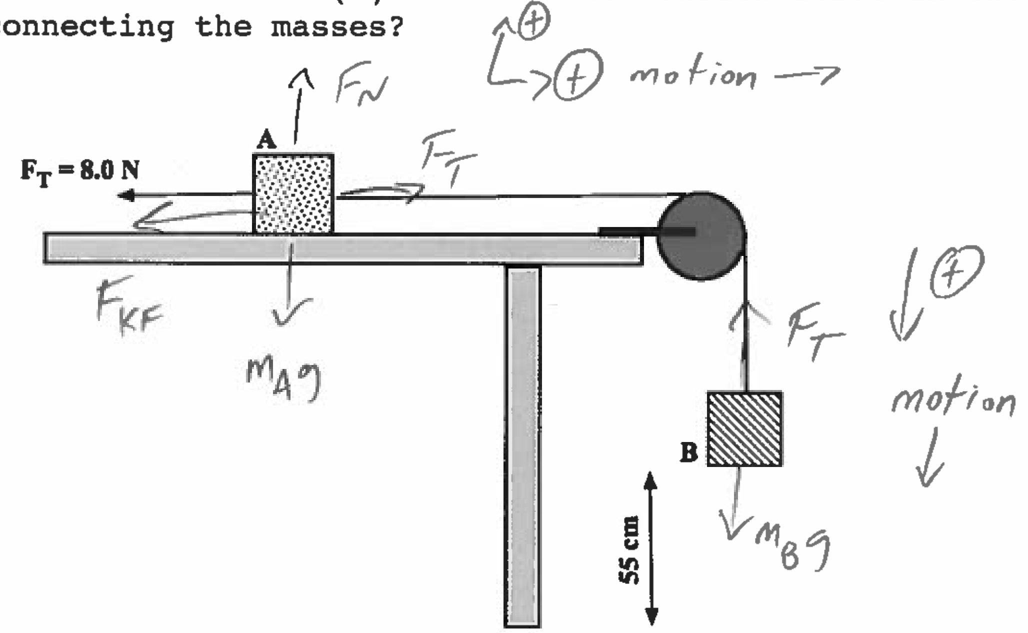
b) For max speed $F_{SF} = F_{SF,MAX} = \mu_s F_N$

$$\Sigma F_y = F_N - F_{down} - mg = 0 \Rightarrow F_N = 25160\ N$$

$$\Sigma F_{rad} = \frac{mv^2}{r} - \mu_s F_N = 0$$

$$\mu_s = \frac{mv^2}{rF_N} = \frac{(1700)(46.035)^2}{(170)(25160)} = \boxed{0.84}$$

2. (35 pts) In the diagram below, Mass A is 2.5 kg, and Mass B is 4.9 kg. Another string attached to block A pulls with a tension force of 8.0 N parallel to the horizontal surface as shown. The coefficient of kinetic friction between mass A and the table is 0.32. (a) If the system is set in motion starting from rest, how much time does it take for mass B to descend 55 cm to the floor? (b) What is the tension force in the string connecting the masses?



$A: \Sigma F_x: F_T - 8.0 - \mu_K F_N = m_A a$

$F_T - 8.0 - \mu_K m_A g = m_A a$

$F_T - 8.0 - 7.84 = m_A a \Rightarrow F_T = m_A a + 15.5$

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

$-m_A a - 15.54 + m_B g = m_B a$

$m_B g - 15.54 = (m_A + m_B) a$

$32.48 = 7.4 a \Rightarrow a = 4.39\ m/s^2$

$\Delta y = 0.55$

$v_0 = 0$

$a = 4.39\ m/s^2$

$0.55 = 0 + \frac{1}{2}(4.39) t^2$

$\Rightarrow \boxed{t = .50\ s}$

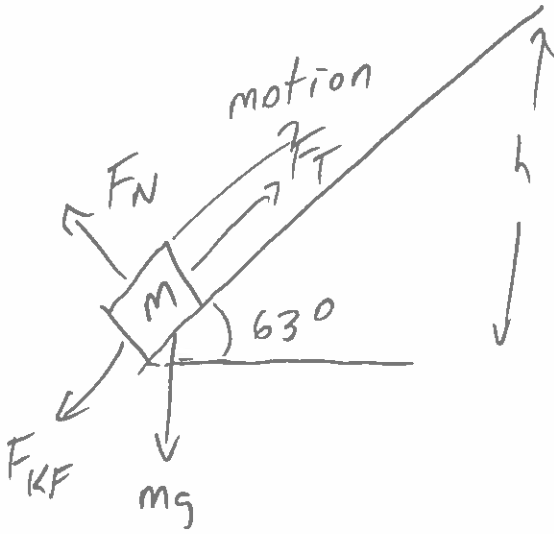
$F_T = (2.5)(4.39) + 15.54$

$= \boxed{27\ N}$

3. (35 pts) A 65-kg block is on a 7.5-meter long incline that makes a 63° angle above the horizontal. The block is pulled up the incline at a constant speed of 1.5 m/s by a rope parallel to the incline. The coefficient of kinetic friction between the block and incline is 0.42.

a) How much work is done by the force of kinetic friction as the block slides up the incline?

b) What power (in Watts) is supplied by the tension force in the rope during the block's motion?



$h = 7.5 \sin 63°$

$= 6.68\ m$

$W_N = 0$

$W_g = -mgh$

$= -(65)(9.8)(6.68)$

$= -4257\ J$

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

$= -\mu_K mg \cos 63° \Delta s$

$= -(.42)(65)(9.8)\cos 63° (7.5)$

$= \boxed{-910\ J}$

$\Sigma W_F = W_N + W_g + W_{KF} + W_T = \Delta K$

$0 - 4257 - 910 + W_T = 0$ ← constant speed

$W_T = 5168\ J$

time: $\frac{\Delta s}{v} = \frac{7.5}{1.5} = 5.0\ s$

$P_T = \frac{5168}{5} = \boxed{1000\ \text{Watts}}$