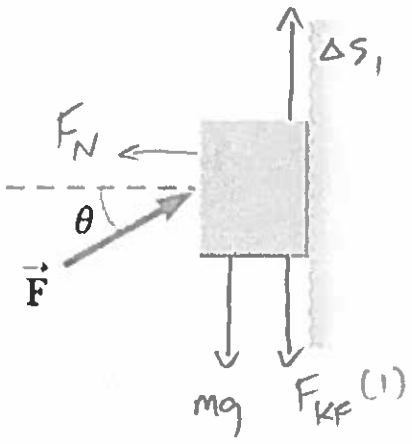
Physics 10154 – Exam #2A

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. (35 pts) A 7.87 kg block is sliding up or down a vertical wall. The coefficient of kinetic friction is 0.250. An applied force pushes on the block, making an angle of 33° above the horizontal as shown below.

a) For case 1, the block slides up the wall with a constant velocity of 3.50 m/s. What is the magnitude of the applied force?

b) For case 2, the block slides DOWN the wall with a constant velocity of 3.50 m/s. What is the magnitude of the applied force?



$$\Sigma F_x = F_{App}\cos 33^\circ - F_N = 0$$

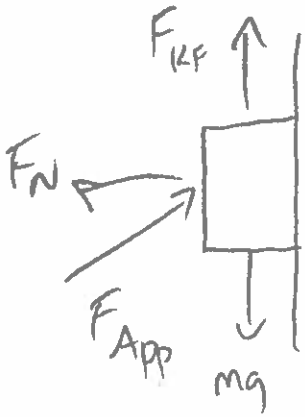
$$\Sigma F_y = F_{App}\sin 33 - mg - \mu_K F_N = 0$$

$$F_{App}\sin 33 = mg + \mu_K F_{App}\cos 33^\circ$$

$$F_{App}(\sin 33^\circ - \mu_K \cos 33^\circ) = mg$$

$$F_{App}(.545 - .210) = (7.87)(9.8)$$

$$\boxed{F_{App} = 230\ N}$$



ΣF_x same $\Sigma F_y = F_{App}\sin 33^\circ - mg + \mu_K F_N = 0$

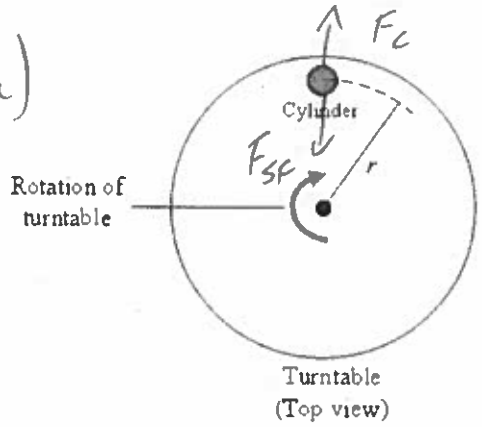
$$F_{App}\sin 33^\circ + \mu_K F_{App}\cos 33^\circ = mg$$

$$F_{App}(.545 + .210) = mg$$

$$\boxed{F_{App} = 102\ N}$$

2. (30 pts) A small cylinder rests on a circular turntable that is rotating clockwise at a constant speed. The cylinder is at a distance r = 17 cm from the center of the turntable. The coefficient of static friction between the cylinder and turntable is 0.56. The turntable is accelerated from rest until the cylinder begins to slide off the edge. At that instant, what is (a) the velocity of the cylinder and (b) the period of rotation of the turntable?

a)



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

"begins to slide" $\Rightarrow F_{SF} = \mu_s F_N$

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

$$\frac{mv^2}{r} - \mu_s mg = 0$$

$$\frac{v^2}{r} = \mu_s g \Rightarrow v = \sqrt{\mu_s g r}$$

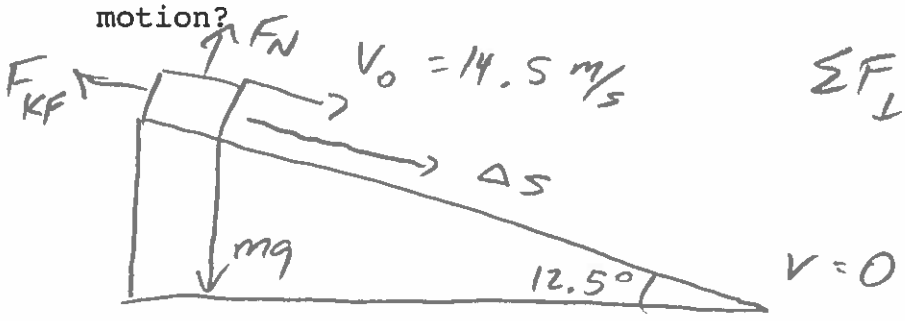
$$= \boxed{0.97\ m/s}$$

b) $2\pi r = vT$

$$T = \frac{2\pi r}{v} = \frac{2\pi(.17)}{0.97} = \boxed{1.1\ s}$$

3. (35 pts) A 3540-kg truck is traveling with a speed of 14.5 m/s down a hill when the brakes on all four wheels lock. The hill makes an angle of 12.5° with respect to the horizontal. The coefficient of kinetic friction between the tires and the road is 0.782.

a) How far does the truck move before coming to a stop?
b) How much work is done by the frictional force during this motion?



$\Sigma F_\perp = F_N - mg\cos 12.5° = 0$

$F_N = mg\cos 12.5°$

a) $W_N = 0$

$W_{grav} = +mgh = mg\,\Delta s \sin 12.5°$

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

$= -\mu_k (mg\cos 12.5°)\Delta s$

$0 + mg\,\Delta s \sin 12.5° - \mu_k mg\cos 12.5°\,\Delta s = 0 - \frac{1}{2}mv_0^2$

$7508.72\,\Delta s - 26486.07\,\Delta s = -372142.5$

$\Delta s = \dfrac{-372142.5}{-18977.35} = \boxed{19.6\ m}$

b) $W_{KF} = -(26486.07)(19.6) = \boxed{-519000\ J}$

or $-5.19 \times 10^5\ J$