Quiz 5

Name:____________________

(1) Suppose you are standing on a train accelerating at 0.20 *g*.
What is the *minimum coefficient of static friction* required between your feet and the floor to prevent slipping?

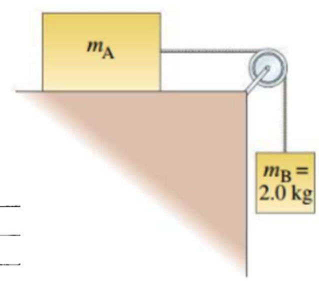
$\mu_s F_N = F_{fr} \geq ma$

$\mu_s F_N = \mu_s mg \geq ma$

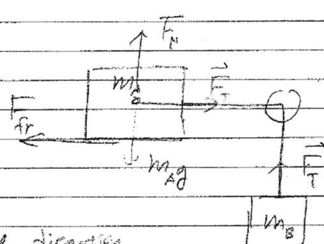
$\mu_s \geq \frac{\cancel{m}a}{\cancel{m}g} = \frac{a}{g} = \frac{0.20\cancel{g}}{\cancel{g}}$

$\therefore \boxed{\mu_s \geq 0.20}$

(2) In the system shown in the figure, the coefficient of static friction between mass m_A and the table is 0.40, and the coefficient of kinetic friction is 0.30.
(a) What is the *minimum value of m_A* that will keep the system from starting to move?
(b) What value(s) of m_A will keep the system moving at *constant speed*?



-23) (a)



In the horizontal direction,

Newton's 2nd law

$F_{fr} - F_T = ma = 0$ (no acceleration) & m_A at rest

$F_{fr} = F_T \rightarrow F_{fr} \geq F_T$

at least m_A ~~remains at rest~~

$F_{fr} = \mu_s F_N (= \mu_s m_A g) \geq F_T (= m_B g)$

$\therefore \mu_s m_A g \geq m_B g \rightarrow m_A \geq \frac{m_B}{\mu_s} = \frac{2.0\ kg}{0.40}$

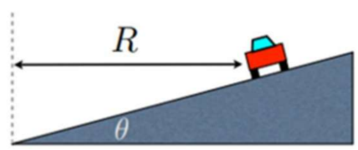
$= \boxed{5.0\ kg}$ the minimum mass

Still $F_{fr} - F_T = ma$ but $ma = 0$ (since now it moves at constant speed)

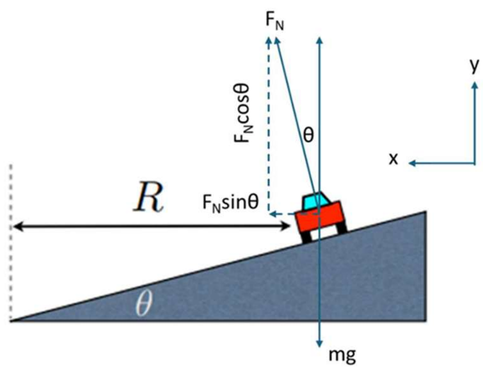
$F_{fr} = F_T \rightarrow \mu_k m_A g = m_B g$

$m_A = \dfrac{m_B}{\mu_k} = \dfrac{2.0\ \text{kg}}{0.30} = \boxed{6.7\ \text{kg}}$

(3) A car of mass *m* is running on a banked circular track where the banked surface has an angle θ with respect to the horizontal line. The car moves with a horizontal radius R from the symmetric axis of the circular track, as shown in the figure. Assume negligible friction between the tires and the surface. The car runs at a constant speed. Find the speed *v* of the car in terms of the given variables and relevant physical constants.



Solution



In y, $F_n\cos\theta = mg \rightarrow F_n = mg/\cos\theta$

In x, $F_n\sin\theta = ma_c = m\,(v^2/R)$

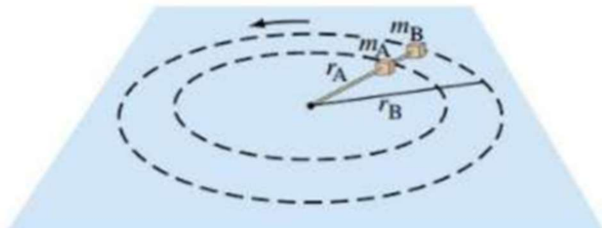
From $F_n = mg/\cos\theta$, $(mg/\cos\theta)\sin\theta = m\,(v^2/R)$

$g\tan\theta = v^2/R$,

Solving for v, $v = \sqrt{Rg\tan\theta}$

(4) Two blocks, with masses m_A and m_B, are connected to each other and to a central post by cords, as shown in the figure. They rotate about the post at frequency *f* (revolutions per second) on a frictionless horizontal surface at distances r_A and r_B from the post.

Derive an algebraic expression for the *tension in each segment* of the cord (assumed massless).



~~Two~~ Two tensions we need to find

T_{AB} : Tension between m_A & m_B

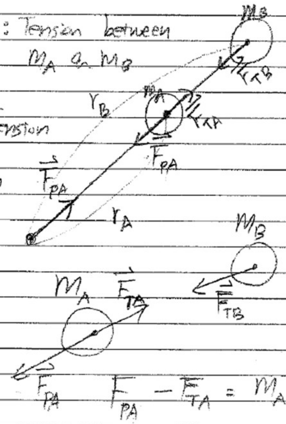
Tension on A

$F_{TA} = F_{TB} = T_{AB}$

Tension on B

F_{PA} : Tension between the post & m_A

F_{TP} : Tension on A by the post.



$$\boxed{F_{TB} = m_B \frac{v_B^2}{r_B} = T_{AB}}$$

$$F_{PA} - F_{TA} = m_A \frac{v_A^2}{r_A}$$

$$F_{TB} = T_{AB}$$

$$\therefore\ F_{PA} = F_{TA} + m_A \frac{v_A^2}{r_A} = \boxed{m_B \frac{v_B^2}{r_B} + m_A \frac{v_A^2}{r_A}}$$

Further analysis for v (speed):

$$v = f\left(\frac{rev}{sec}\right) = f(2\pi r)$$

$$T_{AB} = m_B \frac{(f\,2\pi r_B)^2}{r_B} = 4\pi^2 r_B f^2 m_B$$

$$F_{PA} = 4\pi^2 r_B f^2 m_B + m_A \frac{(f\,2\pi r_A)^2}{r_A} = \boxed{4\pi^2 f^2 (m_B r_B + m_A r_A)}$$