PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Spring Semester 2015**

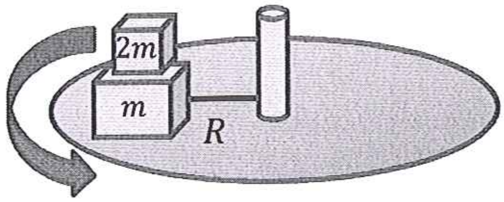
College of Arts and Sciences

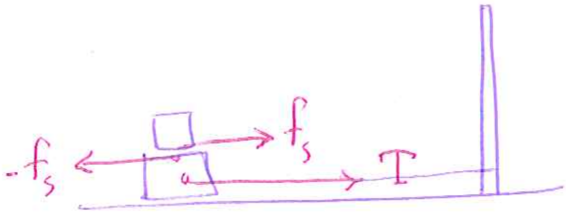
Section **Quiz 5-1** **March 2015**

Closed book. Duration:

Name: **Student ID:** **Signature:**

A box of mass 2m is placed on another box of mass m on a frictionless table. The box m is attached by a massless string of length R to a pivot and the boxes are in uniform circular motion together. The static friction coefficient between the boxes is $\mu_s = 0.75$. Find the tension in the string just before the box at the top of the other starts to slide.





For the mass 2m we have just one force that holds it at circular motion that is f_s. We know that maximum of f_s is $f_{smax} = \mu_s n = \mu_s 2mg$. In radial direction we have: $f_s = 2ma_r \Rightarrow f_{smax} = 2m\,a_{rmax} \Rightarrow \mu_s 2mg = 2m\,a_{rmax}$

$\Rightarrow a_{rmax} = \mu_s g$

For the other mass with mass m we can write:

$T - f_s = ma_r \Rightarrow T_{max} - f_{smax} = ma_{rmax} \Rightarrow$

$\Rightarrow T_{max} = ma_{rmax} + 2ma_{rmax} = 3ma_{rmax} = 3ma_{rmax} = 3m\mu_s g$

$\Rightarrow \boxed{T_{max} = 3mg\mu_s} \simeq 22\,m$

PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Spring Semester 2015**

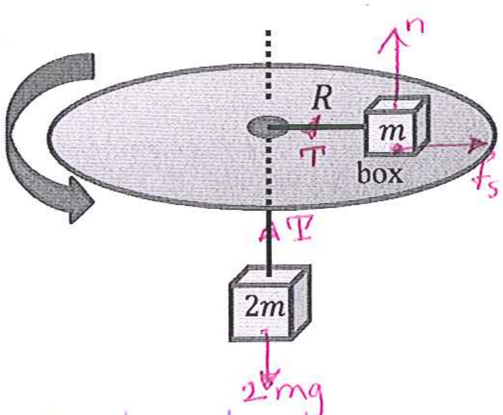
College of Arts and Sciences

Section **Quiz 5-2** **March 2015**

Closed book. Duration:

Name: **Student ID:** **Signature:**

A circular plate can rotate around an axis about its center as shown in the figure. A box of mass m is placed at a distance R from the center axis and it is connected by a massless rope through a hole at the center of the plate to another object of mass 2m. The static friction coefficient between the plate and the box is μ_s=0.75. Assume that the rope is free to move (without friction) through the hole. Determine the minimum linear speed of the box during uniform circular motion so that the box does not slide.



When the box does not slide the hung mass also does not move and we have: $T = 2mg$.

For the box when the linear speed goes to minimum, it tends to slide toward the axis of rotation thus the friction will be outward the center of rotation. we have: $f_s \leq \mu_s n = \mu_s mg \Rightarrow f_{s\,max} = \mu_s mg$

In radial direction the sum of T and f_s provides the centripetal force

$$T - f_s = ma_r \Rightarrow T - f_{s\,max} = ma_{r\,min} \Rightarrow 2mg - \mu_s mg = m a_{r\,min}$$

Knowing $a_r = \frac{v^2}{R} \Rightarrow a_{r\,min} = \frac{v^2_{min}}{R}$ we have: $(2-\mu_s)g = \frac{v^2_{min}}{R}$

$$\Rightarrow v_{min} = \sqrt{Rg(2-\mu_s)} = \sqrt{1.25gR}$$

PHYS 101: General Physics 1 KOÇ UNIVERSITY Spring Semester 2015

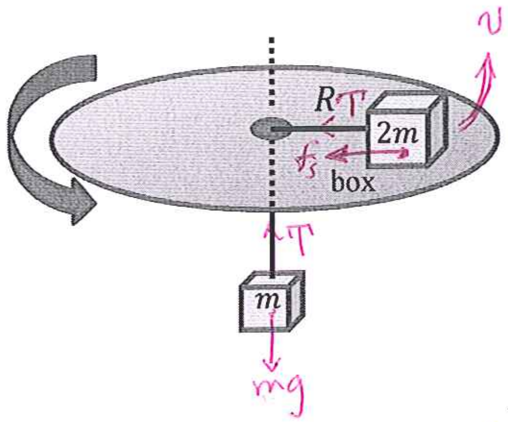
College of Arts and Sciences

Section Quiz 5-3 March 2015

Closed book. Duration:

Name: Student ID: Signature:

A circular plate can rotate around an axis about its center as shown in the figure. A box of mass 2m is placed at a distance R from the center axis and it is connected by a massless rope through a hole at the center of the plate to another object of mass m. The static friction coefficient between the plate and the box is μ_s=0.75. Assume that the rope is free to move (without friction) through the hole. Determine the maximum linear speed of the box during uniform circular motion so that the box does not slide.



When the box does not slide the hung mass also does not move and we have: $T = mg$.

For the box when linear speed goes to maximum, it tends to scape from the center of rotation so the friction force will act toward the center of rotation. The maximum for static friction is: $f_{s\,max} = \mu_s n = \mu_s 2mg$

Now in the radial direction the sum of T and f_s provides centripetal force:

$$T + f_s = 2ma_r \Rightarrow T + f_{s\,max} = 2ma_{r\,max} \Rightarrow$$

$$\cancel{m}g + \mu_s 2\cancel{m}g = 2\cancel{m}a_{r\,max} \Rightarrow \text{Knowing } a_r = \frac{v^2}{R} \Rightarrow a_{r\,max} = \frac{v^2_{max}}{R}$$

$$(2\mu_s + 1)g = 2\frac{v^2_{max}}{R} \Rightarrow v_{max} = \sqrt{\frac{Rg}{2}(2\mu_s + 1)} \simeq 3.5\sqrt{R}$$