PHYS 101: General Physics 1 KOÇ UNIVERSITY Fall Semester 2016

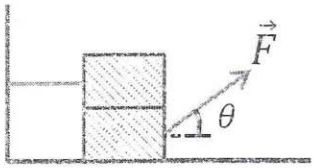
College of Arts and Sciences

Section 1 Quiz 4&5-1 November 2016

Closed book. No calculators are to be used for this quiz.
Quiz duration: 20 minutes

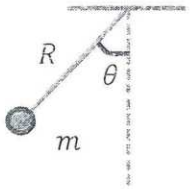
Name: **Student ID:** **Signature:**

1. [100 pts.] Two identical boxes, each of mass m are stacked on a frictionless ground. The coefficient of kinetic friction between boxes is μ_k. The box at the top is attached by a horizontal rope to the wall. The box at the bottom is pulled by a constant force $\vec{F}$ that makes an angle θ with the horizontal as shown and this box moves with constant speed.



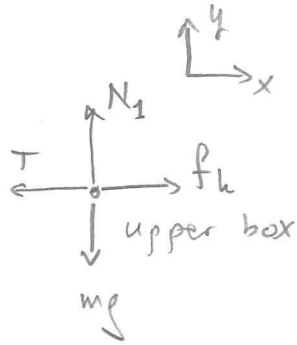
   a) Draw the free-body diagram of each box accurately.
   b) Determine the tension in the string in terms of m, g, θ, μ_k.

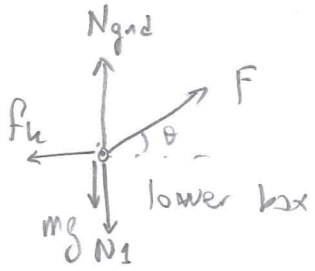
2. [100 pts.] A pendulum consists of a mass m attached to the end of a rope of length R. The pendulum swings with a maximum angle of θ_{max} with the vertical.



   a) Draw the free-body diagram of the mass at the instant when $\theta = 30^o < \theta_{max}$ as shown. Show the direction of the acceleration $\vec{a}$ of the mass clearly in this diagram.
   b) Determine the tension in the string if the speed of the particle is equal to $\sqrt{\frac{gR}{2}}$ at part (a).
   ($\sin 30^o = 0.50,\ \cos 30^o = 0.87$)

1) a)



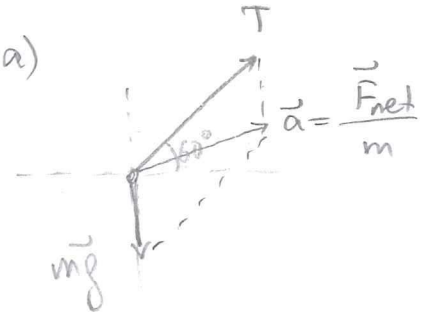


b) Upper box at rest (equilibrium) $\Sigma F_x = 0 = T - f_k = T - \mu_k N_1$

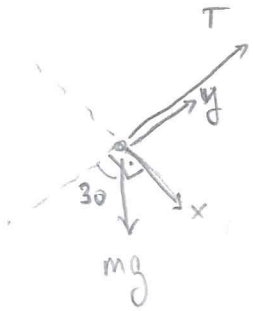
$$\Sigma F_y = 0 = N_1 - mg$$

$$\Rightarrow \boxed{T = \mu_k N_1 = \mu_k mg}$$

2) a)



b) Use a coordinate system as follows



$$\Sigma F_x = m a_x = m a_{\parallel}$$

$$\Sigma F_y = m a_y = m a_{\perp} = m a_{rad}$$

$$\Sigma F_y = T - mg\cos\vartheta = m a_{rad} = m\frac{v^2}{R} = \frac{mg}{2}$$

$$\boxed{T = \frac{mg}{2}(1+\sqrt{3})}$$

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Section 2 Quiz 4&5-2 November 2016

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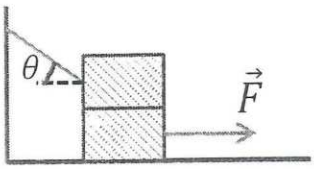
Quiz duration: 20 minutes

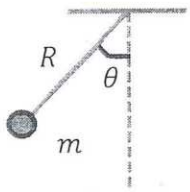
Name: **Student ID:** **Signature:**

1. [100 pts.] Two identical boxes, each of mass m are stacked on a frictionless ground. The coefficient of kinetic friction between boxes is μ_k. The box at the top is attached to the wall by a rope that makes an angle θ with the horizontal as shown. The box at the bottom is being pulled by a constant force $\vec{F}$ horizontally and it moves with constant speed.



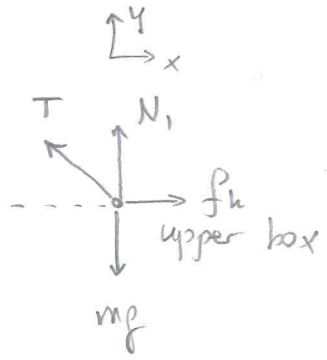
   a) Draw the free-body diagram of each box accurately.
   b) Determine the tension in the string in terms of m, g, θ, μ_k.

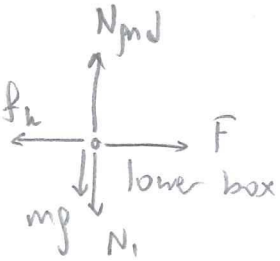
2. [100 pts.] A pendulum consists of a mass m attached to the end of a rope of length R. The pendulum swings with a maximum angle of θ_{max}.



   a) Draw the free-body diagram of the mass when $\theta = \theta_{max}$ as shown. Show the direction of the acceleration $\vec{a}$ of the mass clearly in this diagram.
   b) Determine the tension in the string at part (a).

1 a)





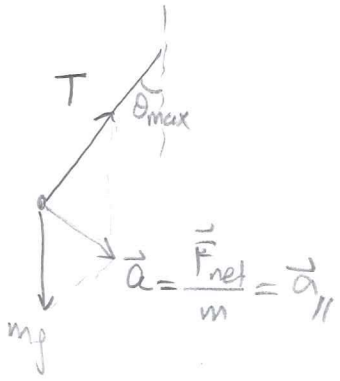
b) Upper box at equilibrium: $\sum F_x = 0 = f_k - T\cos\theta$, $f_k = \mu_k N_1$

$$\sum F_y = 0 = T\sin\theta + N_1 - mg = 0$$

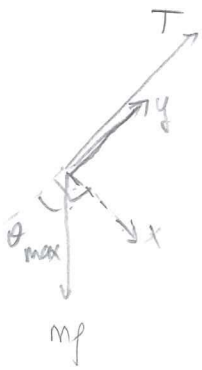
$$\mu_k(mg - T\sin\theta) - T\cos\theta = 0$$

$$\boxed{T = \frac{\mu_k mg}{\cos\theta + \mu_k \sin\theta}}$$

2 a)



b) Use a coordinate system as follows



$$\sum F_x = ma_x = ma_{\parallel}$$

$$\sum F_y = ma_y = ma_{\perp} = ma_{rad}$$

$$\sum F_y = T - mg\cos\theta = ma_{rad} = \frac{mv^2}{R} = 0$$

$v = 0$ at $\theta = \theta_{max}$

$$T = mg\cos\theta$$

$$\boxed{T = mg\cos\theta_{max}}$$

PHYS 101: General Physics 1 KOÇ UNIVERSITY Fall Semester 2016

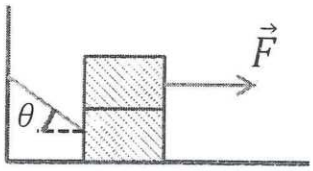
College of Arts and Sciences

Section 3 Quiz 4&5-3 November 2016

Closed book. No calculators are to be used for this quiz.
Quiz duration: 20 minutes

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

1. [100 pts.] Two identical boxes, each of mass m are stacked on a frictionless ground. The coefficient of kinetic friction between boxes is μ_k. The box at the bottom is attached by a rope to the wall. The rope makes an angle θ with the horizontal as shown. The top box is being pulled by a constant force $\vec{F}$ horizontally and it moves with constant speed..

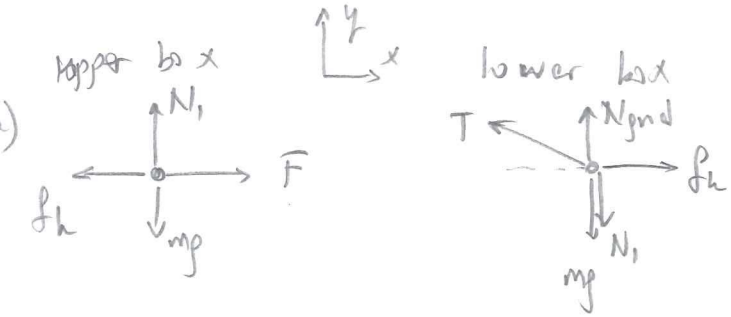


   a) Draw the free-body diagram of each box accurately.
   b) Determine the tension in the string in terms of m, g, θ, μ_k.

2. [100 pts.] A pendulum consists of a mass m attached to the end of a rope of length R. The pendulum swings with a maximum angle of θ_{max}.

   a) Draw the free-body diagram of the mass when it passes from the bottom point as shown. Show the direction of the acceleration $\vec{a}$ of the mass clearly in this diagram.
   b) Determine the linear and tangential acceleration and the speed of the mass if the tension in the string at part(a) is equal to $4mg$.

1 a)



b) lower box at equilibrium:

$$\sum F_x = f_k - T\cos\theta = 0 \qquad f_k = \mu_k N_1$$

$$\sum F_y = N_{gnd} + T\sin\theta - N_1 - mg = 0$$

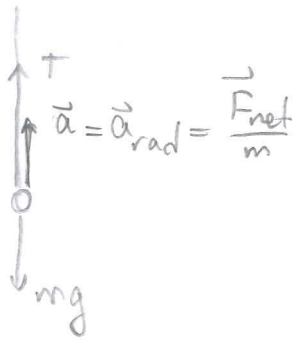
upper box at equilibrium

$$\sum F_x = F - f_k = 0$$

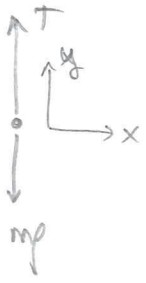
$$\sum F_y = N_1 - mg = 0 \Rightarrow N_1 = mg$$

$$T = \frac{\mu_k N_1}{\cos\theta} = \frac{\mu_k N_1}{mg}$$

2) a)



b) Use a coordinate system as shown



$$\sum F_x = 0 = m a_{tan}$$

$$\boxed{a_{tan} = 0}$$

$$\sum F_y = T - mg = m a_{rad}$$

$$4mg - mg = m a_{rad}$$

$$\boxed{a_{rad} = 3g}$$

$$a_{rad} = \frac{v^2}{R} = 3g \qquad \boxed{v = \sqrt{3gR}}$$

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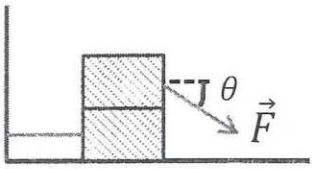
Section 4 Quiz 4&5-4 November 2016

Closed book. No calculators are to be used for this quiz.
Quiz duration: 20 minutes

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

1. [100 pts.] Two identical boxes, each of mass m are stacked on a frictionless ground. The coefficient of kinetic friction between boxes is μ_k. The box at the bottom is attached by a horizontal rope to the wall. The box at the top is being pulled by a constant force $\vec{F}$ that makes an angle θ with the horizontal as shown and this box moves with constant speed.

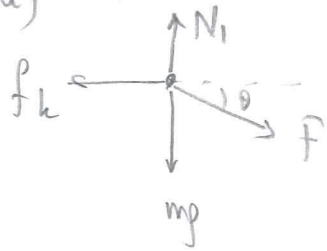


   a) Draw the free-body diagram of each box accurately.
   b) Determine the tension in the string in terms of m, g, θ, μ_k.

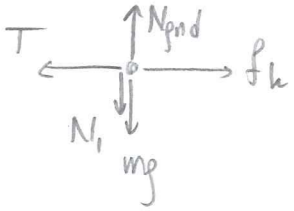
2. [100 pts.] A pendulum consists of a mass m attached to the end of a rope of length R. The pendulum swings with a maximum angle of θ_{max}.

   a) Draw the free-body diagram of the mass when $\theta = 37^o < \theta_{max}$ as shown. Show the direction of the acceleration $\vec{a}$ of the mass clearly in this diagram.
   b) Determine the speed of the particle if the tension in the string at part (a) is equal to mg.
   $(\sin 37^o = 0.60,\ \cos 37^o = 0.80)$

1) a) upper box



lower box



b) lower box in equilibrium:

$$\sum F_x = f_k - T = 0 \Rightarrow T = f_k$$

$$\sum F_y = N_{gnd} - N_1 - mg = 0$$

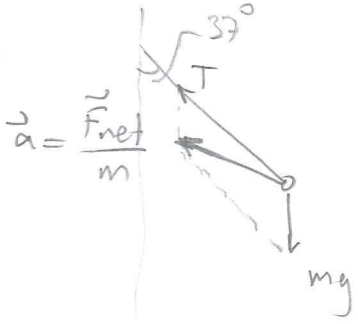
upper box in equilibrium:

$$\sum F_x = F\cos\theta - f_k = 0, \quad f_k = \mu_k N_1$$

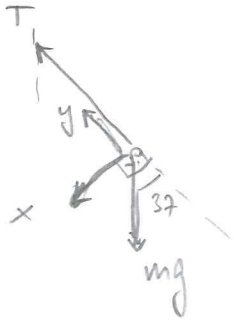
$$\sum F_y = N_1 - mg = 0, \quad N_1 = mg$$

$$\boxed{T = \mu_k mg}$$

2) a)



b) Use a coordinate system as shown



$$\sum F_y = T - mg\cos\theta = ma_{rad}$$

$$= m\frac{v^2}{R}$$

$$mg - mg\cos 37 = m\frac{v^2}{R}$$

$$v = \sqrt{gR(1-\cos 37)}$$

$$\boxed{v = \sqrt{0.2gR}}$$