PHYS 101: General Physics 1 KOÇ UNIVERSITY Fall Semester 2015

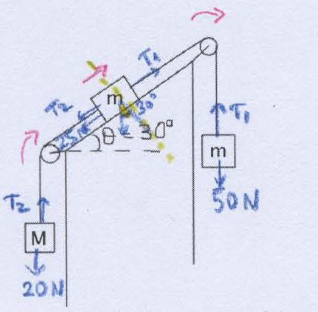
College of Sciences

Section 1 Quiz 4 22 October 2015

Closed book. No calculators are to be used for this quiz.
Quiz duration: 15 minutes

Name: Student ID: Signature:

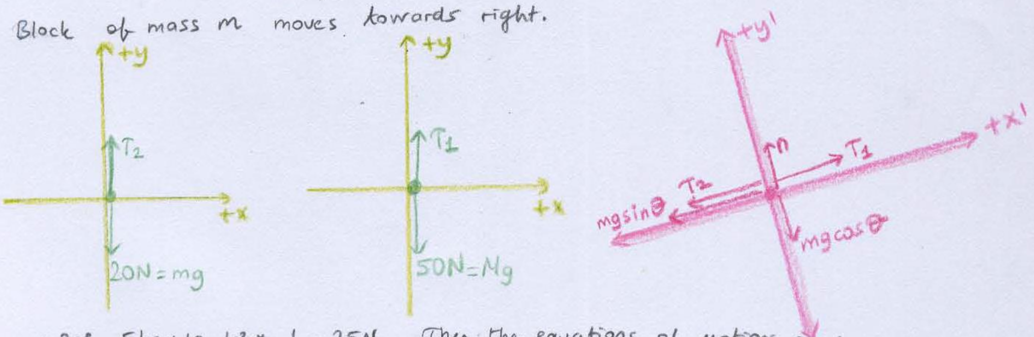
The masses shown in the figure are attached to each other with a massless, unstretchable cord, passing over massless and frictionless pulleys. Draw the free body diagrams for the three masses and find the acceleration of mass m standing on the slope with inclination angle of 30^o. Take m = 5 kg, M = 2 kg and g = 10 m/s^2.



$W_M = M \cdot g = 2\,kg * 10\,m/s^2 = 20\,N$

$W_m = m \cdot g = 5\,kg * 10\,m/s^2 = 50\,N$

Block of mass m moves towards right.



$\Rightarrow mg\sin 30° = 5\,kg * 10\,m/s^2 * \frac{1}{2} = 25\,N$. Then, the equations of motions are;

$\Rightarrow 50\,N - T_1 = 5\,kg * a_{sys} \longrightarrow T_1 = 50\,N - 5a_{sys}$

$\Rightarrow T_2 - 20\,N = 2\,kg * a_{sys} \longrightarrow T_2 = 20\,N - 2a_{sys}$

$\Rightarrow T_1 - (T_2 + mg\sin\theta) = 5\,kg \cdot a_{sys}$

$\Rightarrow 50\,N - 5a_{sys} - (20\,N - 2a_{sys} - 25\,N) = 5a_{sys}$

$\Rightarrow 5\,N = 12\,a_{sys}$

$\Rightarrow \boxed{a_{sys} = a_m = \frac{5}{12}\,m/s^2}$

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Section 2 **Quiz 4** **22 October 2015**

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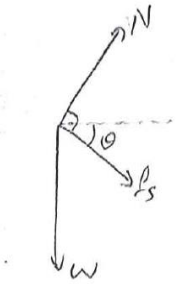
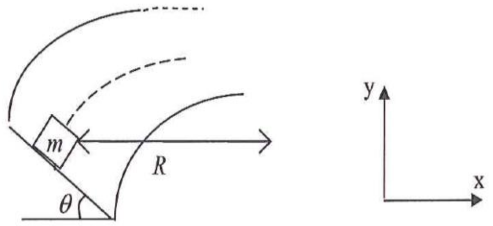
Quiz duration: 15 minutes

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

A car rounds a banked curve (where the coefficient of static friction is μ) as shown in the figure . The radius of curvature of the road is R and the banking angle is θ.

What is the maximum speed the car can have before sliding up the banking (express your answer in terms of R, g, θ and μ). Draw the free body diagram for the car and write the equations of motion in each direction using the coordinate axes given in the figure.





$N_x = N\sin\theta$

$N_y = N\cos\theta$

$f_x = f_s\cos\theta \Rightarrow f_x = \mu_s N\cos\theta$

$f_y = f_s\sin\theta \Rightarrow f_y = \mu_s N\sin\theta$

We know that $\sum_i F_{ix} = m\frac{v^2}{R}$ $\sum_i F_{iy} = 0$

$N_y - w - f_y = 0$

$N_y = mg + \mu_s N\sin\theta$

$N\cos\theta = mg + \mu_s N\sin\theta$

$N = \frac{mg}{\cos\theta - \mu_s\sin\theta}$

$N\sin\theta + \mu_s N\cos\theta = m\frac{v^2}{R}$

$N(\sin\theta + \mu_s N\cos\theta) = m\frac{v^2}{R}$

$\frac{mg}{\cos\theta - \mu_s\sin\theta}(\sin\theta + \mu_s\cos\theta) = m\frac{v^2}{R}$

$$v \leq \sqrt{\frac{gR(\sin\theta + \mu_s\cos\theta)}{\cos\theta - \mu_s\sin\theta}}$$

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Section 3 **Quiz 4** **22 October 2015**

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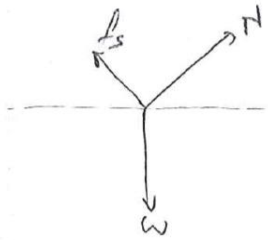
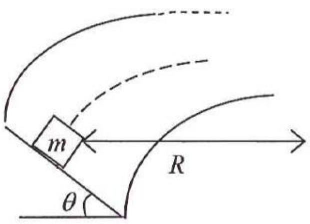
Quiz duration: 15 minutes

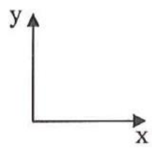
Name: **Student ID:** **Signature:**

A car rounds a banked curve (where the coefficient of static friction is μ) as shown in the figure .The radius of curvature of the road is R and the banking angle is θ.

What is the minimum speed the car can have before sliding down the banking (express your answer in terms of R, g, θ and μ). Draw the free body diagram for the car and write the equations of motion in each direction using the <u>coordinate axes given in the figure.</u>







$N_x = N\sin\theta$

$N_y = N\cos\theta$

$f_x = f_s\cos\theta \Rightarrow f_x = \mu_s N\cos\theta$

$f_y = f_s\sin\theta \Rightarrow f_y = \mu_s N\sin\theta$

$$\sum_i F_{iy} = 0 \Rightarrow \left.\begin{array}{l} N_y - mg + f_y = 0 \\ N\cos\theta - mg + \mu_s N\sin\theta = 0 \end{array}\right\} \Rightarrow N = \frac{mg}{\cos\theta + \mu_s\sin\theta}$$

$$N(\cos\theta + \mu_s\sin\theta) = mg$$

$$\sum_i F_{ix} = \frac{mv^2}{R} \Rightarrow N_x - f_x = \frac{mv^2}{R}$$

$$N\sin\theta - \mu_s N\cos\theta = \frac{mv^2}{R}$$

$$\left(\frac{mg}{\cos\theta + \mu\sin\theta}\right)(\sin\theta - \mu_s\cos\theta) = \frac{mv^2}{R}$$

$$v \geq \sqrt{\frac{gR(\sin\theta - \mu_s\cos\theta)}{\cos\theta + \mu_s\sin\theta}}$$

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Section 4 **Quiz 4** **22 October 2015**

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Quiz duration: 15 minutes

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

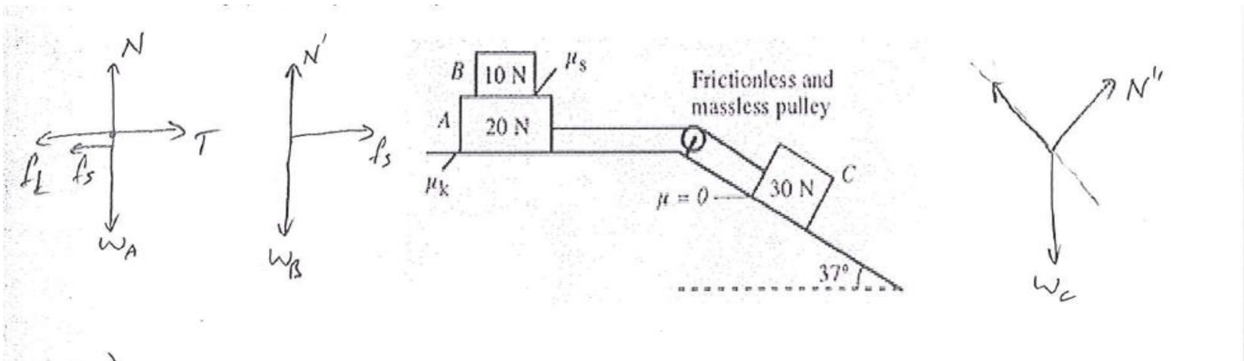
In the figure blocks A, B and C have weights of 20N, 10N and 30N, respectively. The coefficient of static friction between blocks A and B is μ_s and the coefficient of kinetic friction between block A and the horizontal surface is μ_k .There is no friction between block C and the inclined plane. The system of blocks are released from rest. We observe that blocks A and B move together

($g = 10 m/s^2; \sin 37^o = 0.6, \cos 37^o = 0.8$)

a) Draw free-body diagram for each block just after the release.

b) In terms of g and μ_s , what is *a,* the maximum acceleration that block B can have without sliding over block A?

c) If μ_k =0.4, what is the minimum μ_s between A and B so that B does not slip and they (A and B) move together?



b) $m_B g \mu_s = m_B a_{max} \Rightarrow a_{max} = \mu_s g$

c) $m_c g \sin 37° - f_k = (m_A + m_B + m_c) a$

$m_c g \sin 37° - \mu_k (m_A + m_B) g = (m_A + m_B + m_c) a$

$(30 N)\cdot(0.6) - (0.4)(30 N) = (6 kg)(a) \Rightarrow a = 1 m s^{-2}$

$f_s = \mu_s N = m_B a \Rightarrow \mu_s = \frac{m_B a}{N} \Rightarrow \boxed{\mu_s = 0.1}$

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Section 5 **Quiz 4** **22 October 2015**

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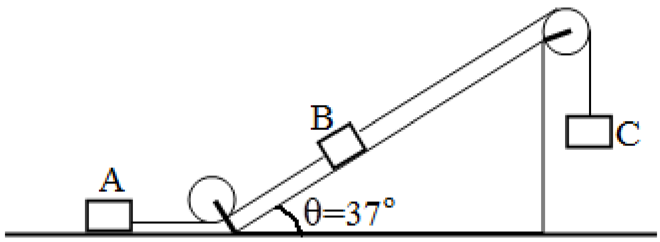
Quiz duration: 15 minutes

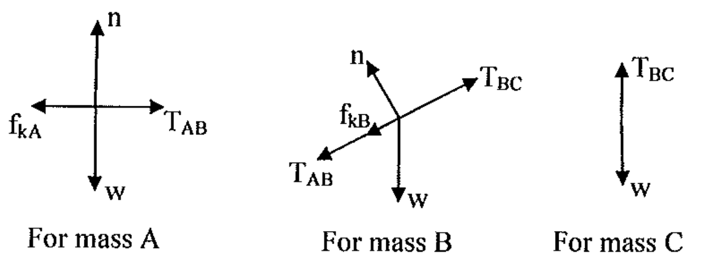
Name: **Student ID:** **Signature:**

Blocks A, B and C are connected by massless strings and pulleys are also massless and frictionless. (See the figure). Both blocks A and B have the same mass, $M_A = M_B = 2.5kg$. The coefficient of kinetic friction between each block and surface is $\mu_k = 0.20$. Block C moves downward with constant speed.

a) Draw three separate free-body diagrams showing all the forces acting on the blocks A, B and C.
b) Calculate the tension in the string connecting blocks A and B.
c) Calculate mass M_C of block C.



a)



b) Since block C moves with constant speed, acceleration of all masses are zero. Therefore, $T_{AB}=f_{kA}$, $f_{kA}=\mu_k m_A g=5N$.

c) Since acceleration is zero, total force acting on the system is zero.

$f_{kA}+f_{kB}+w_{//B}=w_C$, where $w_{//B}$ is the component of the weight of B parallel to the inclined plane.

$f_{kB}=\mu_k m_A g\cos\theta=4N$

$w_{//B}=m_B g\sin\theta=15N \Longrightarrow w_C=24N \Longrightarrow m_C=2.4kg$