PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2011**

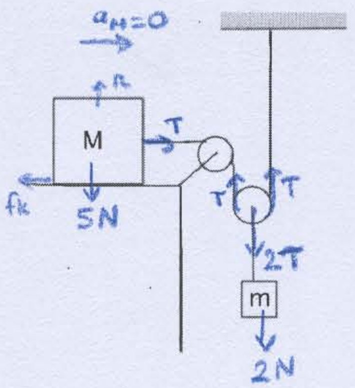
College of Sciences

Section 1 **Quiz 4** **20 October 2011**

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

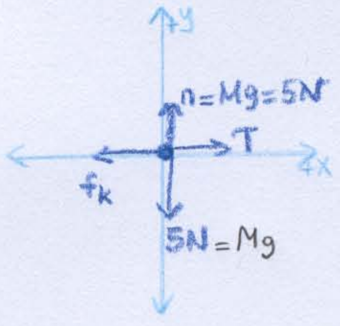
Name: **Student ID:** **Signature:**

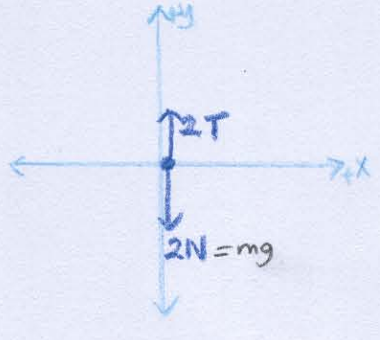
Consider the system shown in the figure, where the particle of mass M = 0.5 kg moves at constant speed towards right on a rough table under the influence of mass m = 0.2 kg. Draw the free body diagrams for masses m and M. What is the coefficient of kinetic friction? Note that the pulleys are massless and frictionless.
(Take $g = 10\ m/s^2$).



$W_m = 0.2\ kg * 10\ m/s^2 = 2\ N$

$W_M = 0.5\ kg * 10\ m/s^2 = 5\ N$





Since the particle of mass M moves at constant speed, we have

$a_M = a_m = a_{system} = 0$

$\Rightarrow 2T = 2N \Rightarrow T = 1N$

$\Rightarrow f_k = \mu_k . n = T = 1N \Rightarrow \mu_k . 5N = 1N \Rightarrow \boxed{\mu_k = \frac{1}{5}}$ the coefficient of kinetic friction

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Section 2 Quiz 4 20 October 2011

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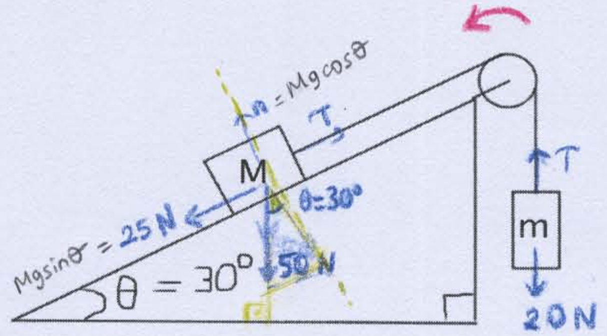
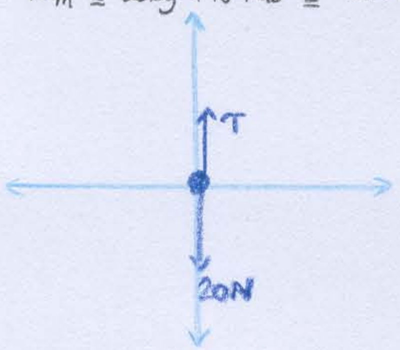
Quiz duration: 15 minutes

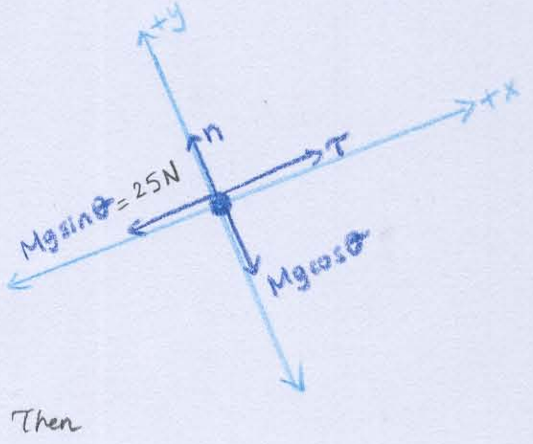
Name: Student ID: Signature:

Consider the system shown in the figure, where the masses m = 2 kg and M = 5 kg are attached to each other with a massless, unstretchable cord, passing over a massless and frictionless pulley. Block of mass M is moving on smooth surface of a heavy wedge. Draw the free body diagrams for masses m and M, and find the acceleration of the masses.
(Take $g = 10\ m/s^2$).



$W_M = 5\,kg * 10\ m/s^2 = 50\ N$
$W_m = 2\,kg * 10\ m/s^2 = 20\ N$





Block of mass M moves towards left. Then

$\Rightarrow T - 20N = 2\,a_{sys}$, $25N - T = 5 \cdot a_{sys}$

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

$\Rightarrow 5N = 7a_{sys}$

$\Rightarrow a_{sys} = a_m = a_M = \frac{5}{7}\ m/s^2$

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Section 3 **Quiz 4** **20 October 2011**

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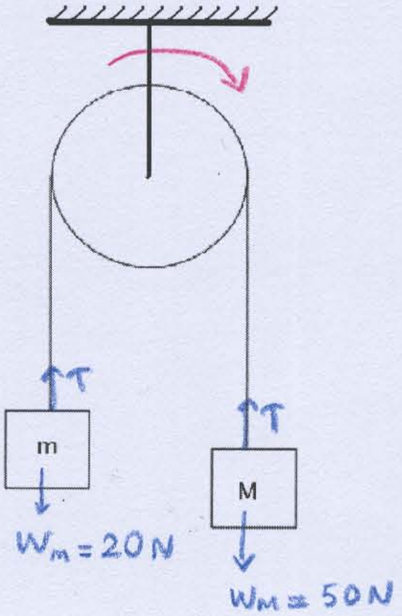
Quiz duration: 15 minutes

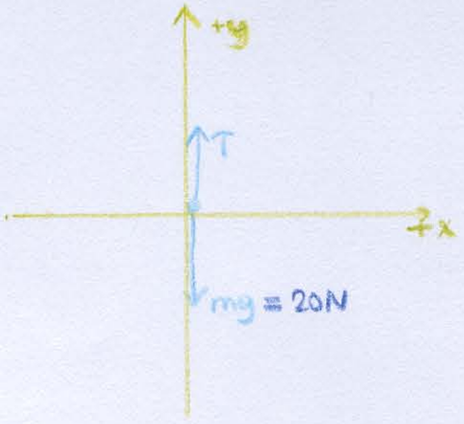
Name: **Student ID:** **Signature:**

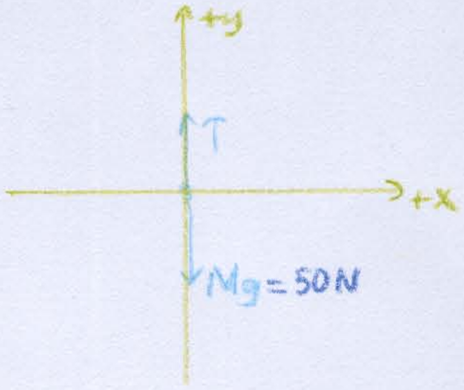
Draw the free body diagrams for the masses m and M, and find the acceleration of the Atwood's machine in the figure if m = 2 kg and M = 5 kg. (Take $g = 10\ m/s^2$). Note that the pulley is frictionless and massless.



$W_m = 2\,kg * 10\,m/s^2 = mg = 20N$

$W_M = M.g = 5\,kg * 10\,m/s^2 = 50N$





The Atwood's machine rotates clockwise.

$\Rightarrow 50N - T = 5 . a_{sys}$ $\qquad T - 20N = 2 . a_{sys}$

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

$\Rightarrow 30N = 7\,a_{sys}$ $\qquad \Rightarrow \boxed{a_{sys} = a_m = a_M = \frac{30}{7}\ m/s^2}$

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Section 4 **Quiz 4** **20 October 2011**

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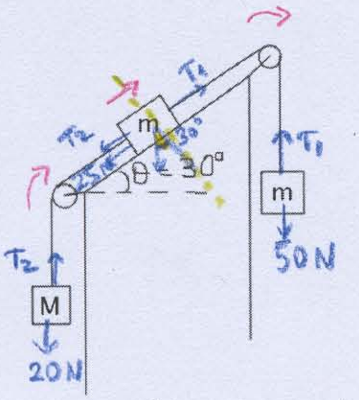
Quiz duration: 15 minutes

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

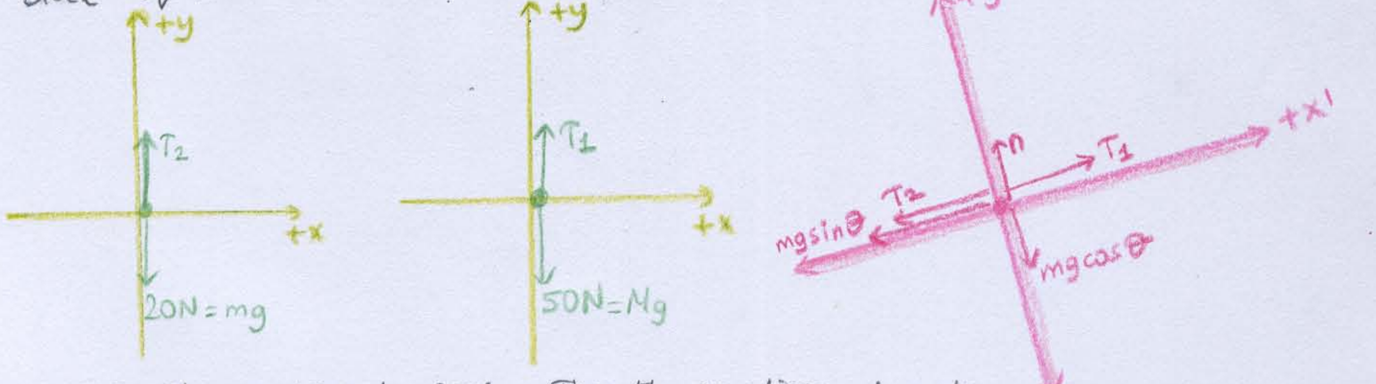
The masses shown in the figure are attached to each other with a massless, unstretchable cord, passing over massless and frictionless pulleys. Draw the free body diagrams for the three masses and find the acceleration of mass m standing on the slope with inclination angle of 30°. Take m = 5 kg, M = 2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

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

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

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

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

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

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

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Section 5 Quiz 4 20 October 2011

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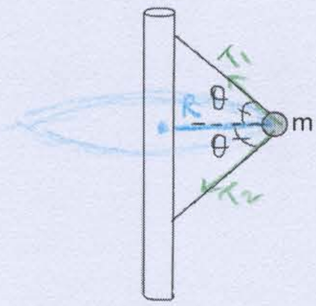
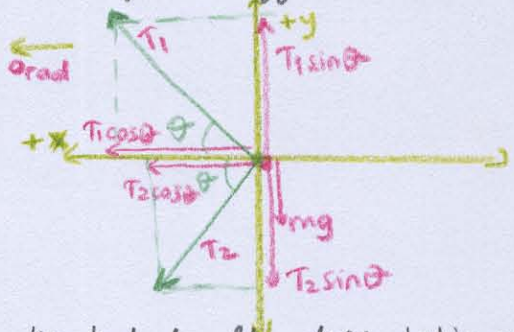
Quiz duration: 15 minutes

Name: Student ID: Signature:

A mass m is attached to a vertical post by two strings, rotates, in a circle of radius R, at constant speed v. At high enough speeds both strings are taut but below a critical velocity the lower string slackens. Draw the free body diagram for mass m and determine this critical velocity and the tension in the upper string at the critical velocity.

This problem resembles with one of the suggested problem 5.110.





The block has acceleration $a_{rad} = \frac{v^2}{R}$ directed to the left. Let's apply $\sum \vec{F} = m\vec{a}$ to the block. Then, $\sum F_x = ma_x$ gives;

$$\Rightarrow T_1 \cos\theta + T_2 \cos\theta = m\frac{v^2}{R}$$

$$\Rightarrow (T_1 + T_2)\cos\theta = \frac{mv^2}{R}$$

$$\Rightarrow v = \mp\sqrt{\frac{(T_1+T_2).R.\cos\theta}{m}} \quad (1)$$

When the lower string slackens, $T_2 \to 0$

$\sum F_y = a_y \Rightarrow$ The tension in the upper string balances the weight of the block. Then $a_y = 0$

$$\Rightarrow T_1 \sin\theta = mg \quad \Rightarrow T_1 = \frac{mg}{\sin\theta}$$

The critical velocity is given by (1)

$$v_c = \sqrt{\frac{(T_1 + 0)R.\cos\theta}{m}} = \sqrt{\frac{mg.R.\cos\theta}{\sin\theta.m}}$$

$$v_c = \sqrt{\frac{gR\cos\theta}{\sin\theta}}$$