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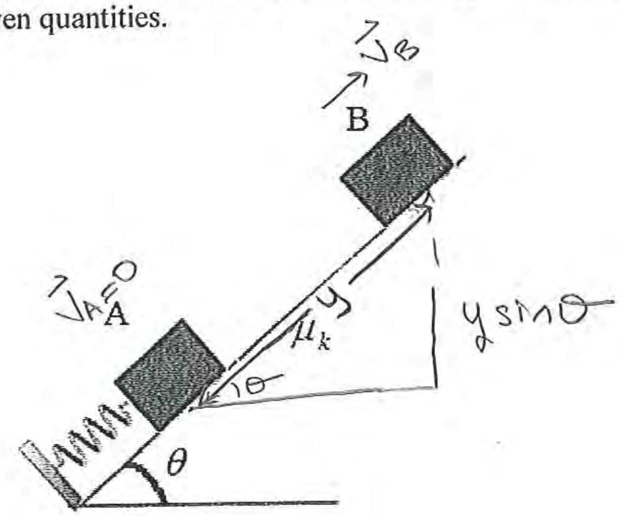
PHYS 101: General Physics **KOÇ UNIVERSITY** **Fall Semester 2013**

College of Sciences

Section 1 **Quiz 7** **14 November 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A block with mass m is placed against a compressed spring at the bottom of an incline with angle θ at point A. When the spring is released, it projects the block up the incline. At point B, a distance of y up the incline from A, the block's velocity is v_B and is no longer in contact with the spring. The coefficient of kinetic friction between the block and the incline is μ_k. The mass of the spring is negligable. Calculate the amount of potential energy that was initially stored in the spring in terms of the given quantities.



* $U_A + K_A + W_{oth} = U_B + K_B$

$U = U_{BLOK} + U_{el}$

at point A;

$U_{BLOK} = 0$ // we take the point A as an origin.

$U_A = 0 + U_{el}$ spring is compressed

$K_A = 0$ // $\vec{V}_A = 0$

at point B;

$U_{BLOCK} = mgy\sin\theta$ // spring is not compressed.

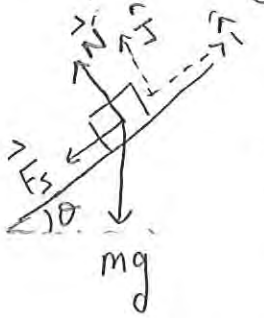
$U_{el} = 0$

$U_B = mgy\sin\theta$

$K_B = \frac{1}{2} m V_B^2$

$W_{oth} = W_f$ $\therefore$ only external force applied is friction.

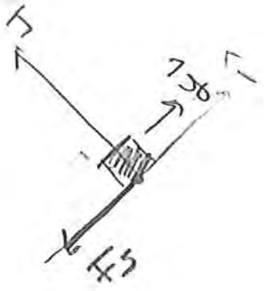
$W_f = \vec{F_s} \cdot \vec{y}$



$\vec{N} = mg\cos\theta\,\hat{j}$

$|F_s| = |N \mu_k|$

$\vec{F_s} = -mg\cos\theta\,\mu_k\,\hat{i}$



$W_f = -mg\cos\theta\,\mu_k\,\hat{i} \cdot y\hat{i}$ $\hat{i} \cdot \hat{i} = 1$

$W_f = -mg\cos\theta\,\mu_k\,y$ //

$W_{oth} = W_f = -mg\cos\theta\,\mu_k\,y$

put all into 1st formula

$U_A + K_A + W_{oth} = U_B + K_B$

$U_{el} + 0 - mg\cos\theta\,\mu_k\,y = mgy\sin\theta + \frac{1}{2}mV_B^2$

$\Rightarrow U_{el} = mgy\sin\theta + \frac{1}{2}mV_B^2 + \mu_k mg\cos\theta\,y$

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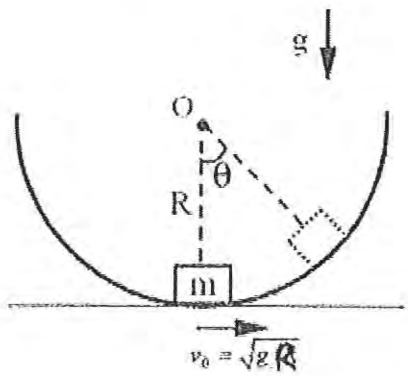
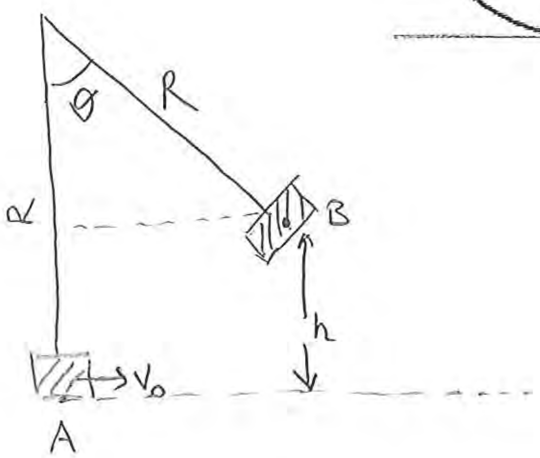
College of Sciences
Section 2 **Quiz 7** **14 November 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A small particle with mass m is moving in a vertical circular track that has a radius R as shown in the figure below. The particle is initially at the lowest point of the track, and has an initial velocity $\sqrt{gR}$ in the direction shown. (g is the magnitude of the gravitational acceleration).

Consider no friction, what is the maximum angle θ that a line from the center of the circle to the particle makes with the vertical when the particle reaches its maximum height?





$h = R - R\cos\theta$

$U_A + K_A + W_{oth} = U_B + K_B$

$W_{oth} = 0$ // no external force is applied
no friction

$U_A = 0$ // on the ground

$K_A = \frac{1}{2} m V_0^2 = \frac{1}{2} m (\sqrt{gR})^2 = \frac{mgR}{2}$

$U_B = mgh$

$= mg(R - R\cos\theta) = mgR(1-\cos\theta)$

$K_B = 0$ // Since it is maximum height $V_B = 0$

put all into;

$\Rightarrow$ "

$$U_A + K_A = U_B + K_B$$

$$0 + \frac{mgR}{2} + 0 = mgR(1-\cos\theta) + 0$$

$$\frac{mgR}{2} = mgR(1-\cos\theta)$$

$$\frac{1}{2} = 1 - \cos\theta \Rightarrow \cos\theta = \frac{1}{2}$$

$$\theta = \arccos\left(\frac{1}{2}\right) = \underline{\underline{60^\circ}}$$

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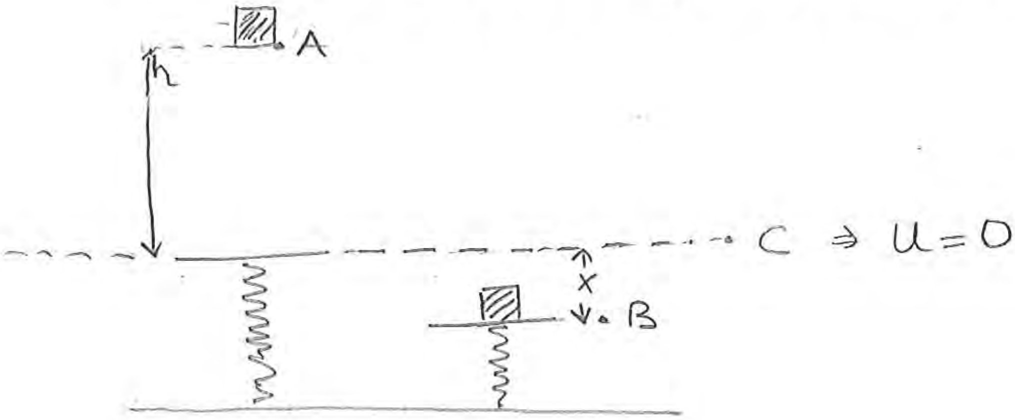
Section 3 **Quiz 7** **14 November 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A block of mass m is dropped from height h onto a spring of spring constant k. Find the maximum distance the string is compressed. (Express your results interms of given quantities.)



$U_A + K_A + W_{oth} = U_B + K_B$

$W_{oth} = 0$ no external force is applied.

$U = U_{BLOCK} + U_{el}$

at point A;

$U_{BLOCK} = mgh$ // if i take the line C as ground level as shown in the figure.

$U_{el} = 0$ // spring is not compressed.

$K_A = 0$ // $V_A = 0$ dropped ⇒ no initial velocity.

at point B;

$U_{BLOCK} = -mgx$ // in negative side of the ground

$U_{el} = \frac{1}{2}kx^2$

$K_B = 0$ // $V_B = 0$ since it is maximum distance at point B.

put all the equations in 1^{st} formula

$$U_A + K_A + W_{oth} = U_B + K_B$$

$$mgh + 0 + 0 = -mgx + \frac{1}{2}kx^2 + 0$$

$$\Rightarrow \frac{1}{2}kx^2 - mgx - mgh = 0$$

Reminder;

$$ax^2 + bx + c = 0$$

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\Rightarrow \quad a = \frac{k}{2}, \quad b = -mg \quad c = -mgh$$

$$x_{1,2} = \frac{+mg \pm \sqrt{m^2g^2 + 4 \cdot \frac{k}{2} mgh}}{k}$$

$$= \frac{mg \pm \sqrt{m^2g^2 + 2mghk}}{k}$$

// we have 1 positive 1 negative answer.

we know that x is in negative side of the ground.

so x is negative

$$x = \frac{mg - \sqrt{m^2g^2 + 2mghk}}{k}.$$

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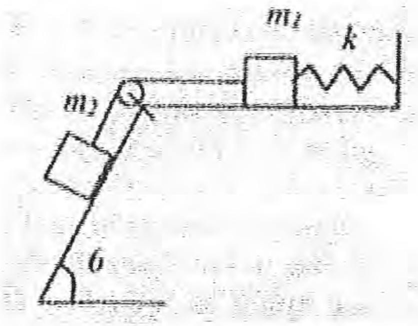
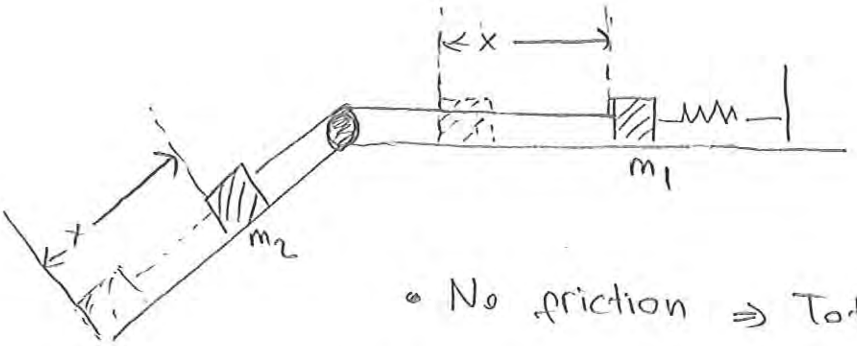
Section 4 **Quiz 7** **14 November 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

In the figure, the block of mass m_1 is connected by a spring to a wall on the right side and to block of mass m_2 by a string through a pulley on the left side. The block m_2 is suspended on an inclined plane. The string is always tight. The gravitational acceleration is g. The whole system is frictionless. Answer the following questions. Express your answer only in terms of masses, g, k and θ.

Suppose that the system is released from the position, when the spring is unstreched/uncompressed and the masses are not moving. What will be the maximum potential energy stored in the spring during the first downward motion?





// Assume spring is streched x, when it has max. potential energy

• No friction ⇒ Total energy is conserved.

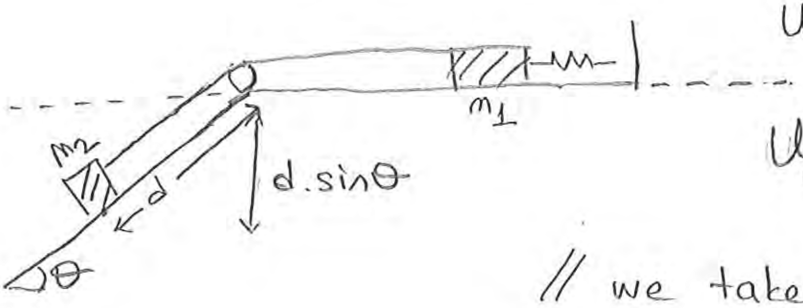
$U_i + K_i = U_f + K_f$

$U = U_{m1} + U_{m2} + U_{el}$

$K = K_{m1} + K_{m2}$

// U_{m1} = potential energy of the block m_1

initial condition



$U_{m_1} = 0$

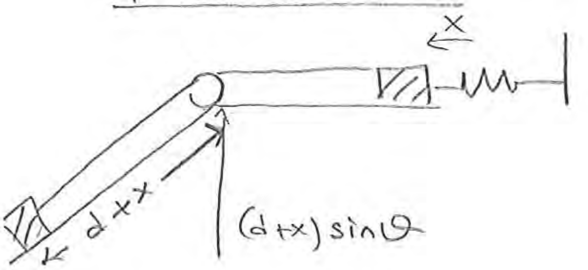
$U_{m_2} = -m_2 g d . \sin\theta$

// we take the ground level "0" as line showed with dashed line (---)

$U_{el} = 0$, initially spring is unstreched.

$U_i = -m_2 g d \sin\theta$ $K_i = 0$; since system is at rest.

final condition



$U_{m_1} = 0$

$U_{m_2} = -m_2 g (d+x) \sin\theta$

$U_{el} = \frac{1}{2} k x^2$

$K_f = 0$: maximum distance that Velocities are zero.

$U_f = -m_2 g (d+x) \sin\theta + \frac{1}{2} k x^2$

$\Rightarrow$ $U_i + K_i = U_f + K_f$

$-m_2 g d \sin\theta + 0 = -m_2 g (d+x) \sin\theta + \frac{1}{2} k x^2 + 0$

$= \cancel{-m_2 g d \sin\theta} = \cancel{-m_2 g d \sin\theta} - m_2 g x \sin\theta + \frac{1}{2} k x^2$

$\frac{1}{2} k x^2 = m_2 g x . \sin\theta$

$x = \frac{2 m_2 g \sin\theta}{k}$; $U_{el} = \frac{1}{2} k x^2 = \frac{2 (m_2 g \sin\theta)^2}{k}$ //

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PHYS 101: General Physics **KOÇ UNIVERSITY** **Fall Semester 2013**

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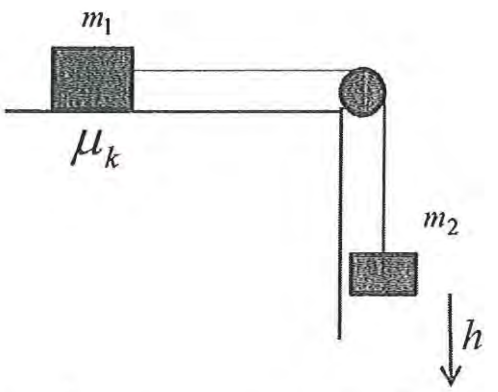
Section 5 **Quiz 7** **14 November 2013**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

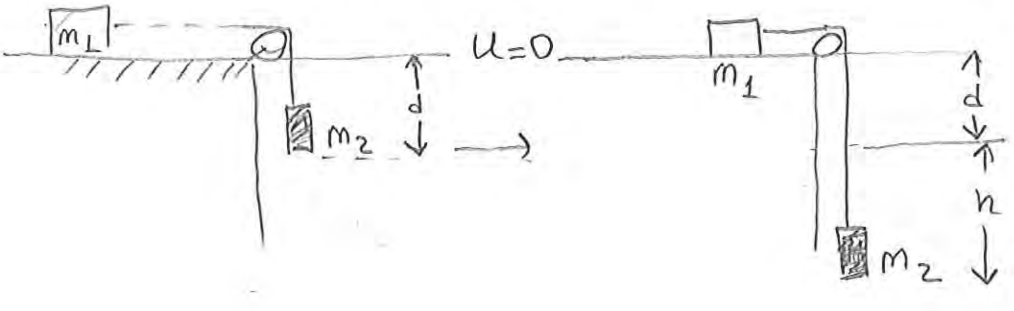
The coefficient of kinetic friction between the block m_1 and the surface is μ_k. The system starts from rest. In terms of the given values, find the speed of m_2 when it has fallen a distance of h.



we have a friction; we need to use the formula;

$U_i + K_i + W_{oth} = U_f + K_f \Rightarrow U = U_{m_1} + U_{m_2}$

$K = K_{m_1} + K_{m_2}$



lets take the top of the surface as ground; (zero level)

initial condition;

$U_{m_1} = 0$ $K_{m_1}, K_{m_2} = 0$

$U_{m_2} = -m_2 g d$ since system is at rest.

$U_i = -m_2 g d$ $K_i = 0$

final condition

$$U_{m_1} = 0$$
$$U_{m_2} = -m_2 g(d+h)$$
$$\Big\} \quad U_f = -m_2 g(d+h)$$

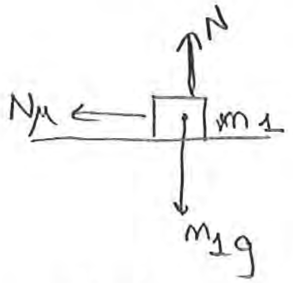
$$K_{m_1} = \frac{1}{2} m_1 V_1^2$$
$$K_{m_2} = \frac{1}{2} m_2 V_2^2$$

$\Big] \quad |V_1| = |V_2|$ they're attached to each other with rope.

$$K_f = \frac{1}{2}(m_1 + m_2) V^2$$

$W_{oth} = W_f \quad \therefore$ we have a friction doing some work

$$W_f = \vec{F_s} \cdot \vec{s}$$



$N = m_1 g$

$F_s = N\mu = m_1 g \mu_k$

$$F_s = -m_1 g \mu_k \hat{i}$$

$\vec{s} = h\hat{i} \leftarrow$ distance that m_1 is moving.

$$W_f = -m_1 g h \mu_k$$

$$\Rightarrow U_i + K_i + W_{oth} = U_f + K_f$$

$$-m_2 g d + 0 - m_1 g h \mu_k = -m_2 g(d+h) + \frac{1}{2}(m_1 + m_2) V^2$$

$$= -m_1 g h \mu_k = -m_2 g h + \frac{1}{2}(m_1 + m_2) V^2$$

$$\Rightarrow V = \sqrt{\frac{2(m_2 g h - m_1 g h \mu_k)}{m_1 + m_2}}$$