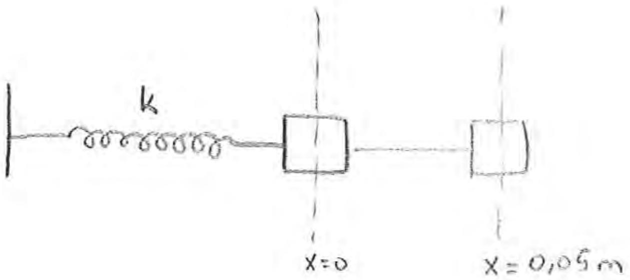
PHYS 101: General Physics **KOÇ UNIVERSITY** **Fall Semester 2013**

College of Arts and Sciences

Section 1 **Quiz 6** **7 November 2013**

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

Consider a spring that does not obey Hooke's Law very faithfully. One end of the soring is fixed. To keep the spring stretched or compressed an amount x, a force along the x-axis with x-component $F_x = kx - bx^2$ must be applied to the free end. Here $k = 100\ N/m$ and $b = 700\ N/m^2$ Note that $x > 0$ when the spring is stretched and $x < 0$ when it is compressed. How much work must be done to stretch this spring by $0.05\ m$?



The force is not constant. So, $W = \int_{x_0}^{x_1} F(x)\,dx$

$$W = \int_0^{0,05} (kx - bx^2)\,dx = \left(\frac{kx^2}{2} - \frac{bx^3}{3}\right)\Bigg|_{x=0}^{x=0,05} = 50.25.10^{-4} - \frac{700.\,1,25.10^{-4}}{3}$$

$$= 1250.10^{-6} - \frac{875}{3}.10^{-6} = \underline{958,3.10^{-6}\ J}$$

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Section 2 **Quiz 6** **7 November 2013**

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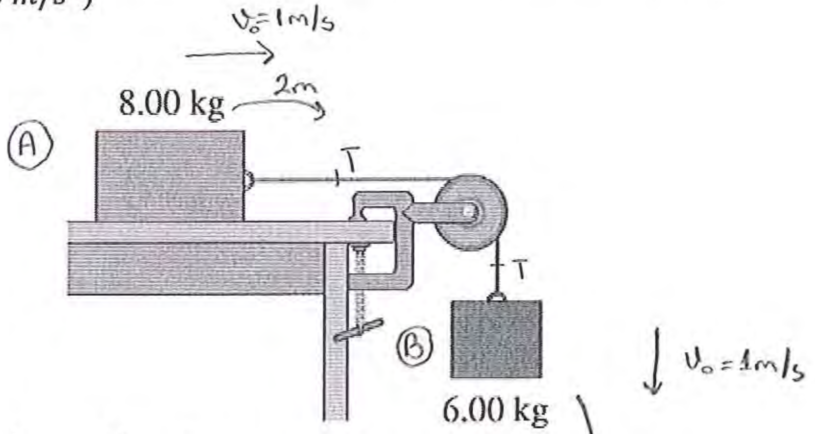
First Name: **Last name:** **Student ID:** **Signature:**

Consider the system shown in Figure below. The rope and pulley have negligible mass, and the pulley is frictionless. Initially the 6 kg block is moving downward and the 8 kg block is moving to the right, both with a speed of 1 m/s. The blocks come to rest after moving 2 m. Use the work-energy theorem to calculate the coefficient of kinetic friction between the 8 kg block and the tabletop. (Take $g = 10\ m/s^2$)



Work-Energy thm: $W_{tot} = K_2 - K_1$

for block B :

it stops after 2m.

$$W_B = (m_B g - T)(2m) = \cancel{K_{B_2}} - K_{B_1}$$

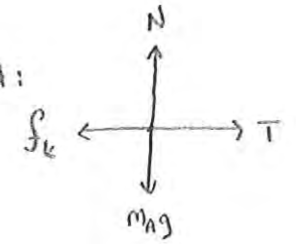
0

$$(60 - T)2 = -\frac{1}{2}6.1^2$$

$$120 - 2T = -3$$

$$T = 61{,}5\ N$$

for block A :



$$W_A = (T - f_k)(2m) = \cancel{K_{A_2}} - K_{A1}$$

0

$$(61{,}5 - \mu_k . m_A g)2 = -\frac{1}{2} m_A 1^2$$

$$123 - 2\mu_k 160 = -4$$

$$\boxed{\mu_k = \frac{127}{320} \simeq 0{,}4}$$

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Section 3 **Quiz 6** **7 November 2013**

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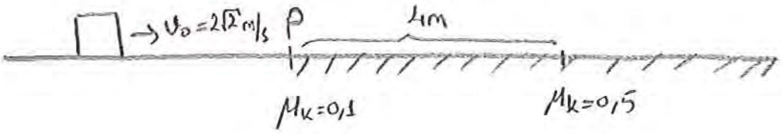
First Name: **Last name:** **Student ID:** **Signature:**

A box is sliding with a speed of $2\sqrt{2}\ m/s$ on a horizontal surface when, at point P, it encounters a rough section. On the rough section, the coefficient of friction is not constant, but starts at 0.1 at P and increases linearly with distance past P, reaching a value of 0.5 at $4\ m$ past point P. Use the work-energy theorem to find how far this box slides before stopping. (Take $g = 10\ m/s^2$)



μ_k is increasing linearly

at 4m μ_k has increased 0,4.

So, we can say that

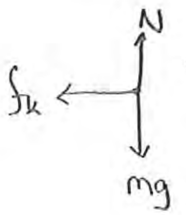
$$\boxed{\mu_k(x) = 0{,}1x + 0{,}1}$$

Check the values:

$x = 0 \Rightarrow \mu_k = 0{,}1$ ✓

$x = 4 \Rightarrow \mu_k = 0{,}5$ ✓

Work-Energy Thm: $W_{tot} = K_2 - K_1$



$$W_{tot} = -\int_0^{x'} f_k(x)dx = -\int_0^{x'} \mu_k(x).mg\,dx$$

x' → final destination

μ_k is a function of x

$$W_{tot} = -mg\int_0^{x'} (0{,}1x + 0{,}1)dx = -mg\left(\frac{0{,}1x^2}{2} + 0{,}1x\right)\Bigg|_{x=0}^{x=x'}$$

$$= -10m\left(0{,}05x'^2 + 0{,}1x'\right) = \underbrace{K_2}_{0} - K_1$$

$$-10\cancel{m}.0{,}05x'^2 - 10\cancel{m}.0{,}1x' = -\frac{1}{2}\cancel{m}(2\sqrt{2})^2$$

$0{,}5x'^2 + x' = 4$ (multiply by 2)

$x'^2 + 2x' - 8 = 0$

$+4 \quad -2$

$x' = -4$
$x' = 2$ } we choose the positive one; $\boxed{x' = 2m}$

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Section 4 **Quiz 6** **7 November 2013**

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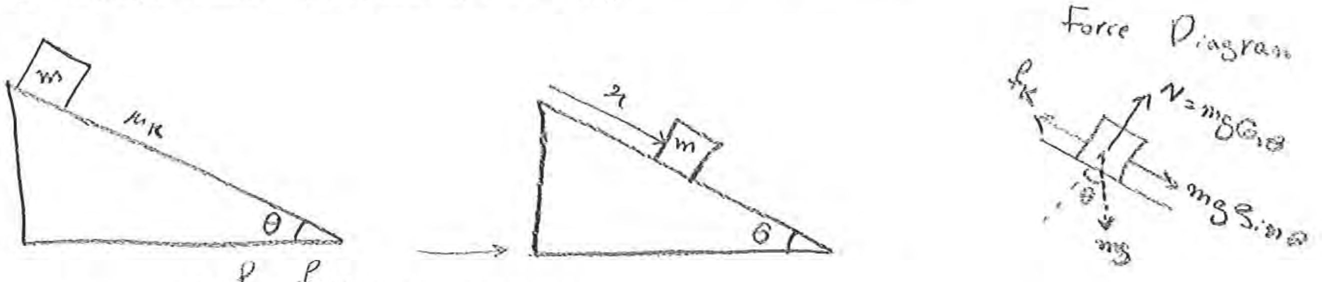
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A block with mass 2 kg slides 2 m down an inclined plane that slopes downward at an angle of 37°. The coefficient of kinetic friction between the inclined plane and the block is 0.2. If the block starts from rest, find its final kinetic energy using the work-energy theorem? (Take $g = 10\,m/s^2$. $\sin 37° = 0.6$ and $\cos 37° = 0.8$)



Net forces $\begin{cases} f_k: \text{friction} = mg\cos\theta\,\mu_k \\ F_g = mg\sin\theta \end{cases}$ $\rightarrow F_{Total} = F_g - f_k$

$\rightarrow W_{net}$: Net Work : $(F_g - f_k)\,x$

$m = 2kg$
$\mu_k = 0.2$ Given
$\theta = 37°$

K_1 : initial Kinetic Energy = 0
$x = 2m$
$g = 10$

Work-energy theorem. $W_{total} = K_2 - K_1 \Rightarrow W_{total} = K_2$

$\Rightarrow (F_g - f_k)\,x = K_2 \rightarrow mg(\sin\theta - \mu_k\cos\theta)\,x = K_2$

$\Rightarrow 2\times 10(\sin 37° - (0.2)\cos 37°) = K_2$

$\Rightarrow K_2 = 2\times 10\,(0.6 - 0.16) = 8.8\ J$

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Section 5 **Quiz 6** **7 November 2013**

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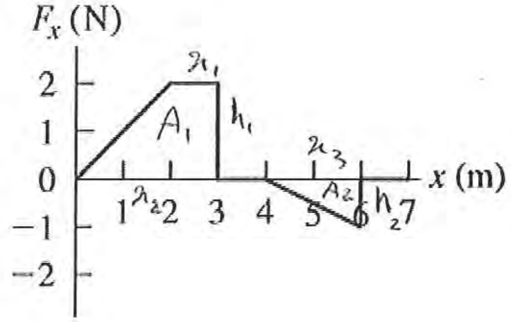
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

A force $\vec{F}$ is applied to a 2 kg block parallel to the x-axis as it moves along a straight track. The x-component of the force varies with the x-coordinate of the car as shown in figure below. Calculate the work done by the force $\vec{F}$ when the car moves from (a) $x = 0$ to $x = 7\,m$.



$$W = \int_{x_1}^{x_2} F\,dx$$ $\rightarrow$ from this relation the integration is the sum of the area A_1 and A_2. But, we should mention that because the force F_x is negative from $x = 4m$ to $x = 6m$ so we should subtract A_1 and A_2

$W = A_1 - A_2$

A_1 = trapezoid $\Rightarrow A_1 = \frac{(x_1 + x_2)\times h}{2} = \frac{(1+3)\times 2}{2} = 4$

A_2 : triangle $\Rightarrow A_2 = \frac{h_2 \times x_3}{2} = \frac{2\times 1}{2} = 1$

$W = A_1 - A_2 = 3$ N.m