PHY 2048-S4, Fall 2009

Examination #2
October 20, 2009
Instructor: Beatriz Roldan Cuenya

Name_______________________________________ID______________

Please answer all questions.

#1______________

#2______________

#3______________

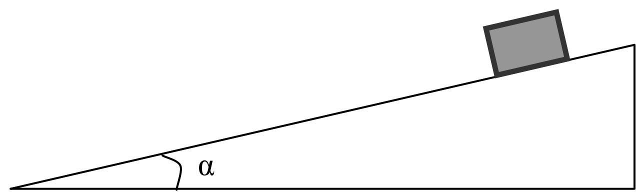
#4______________

Total: ___________

Show all work and enter answers in boxes, if provided.

1. A 0.2 kg block slides along an incline plane with coefficient of kinetic friction μ_k=0.2.

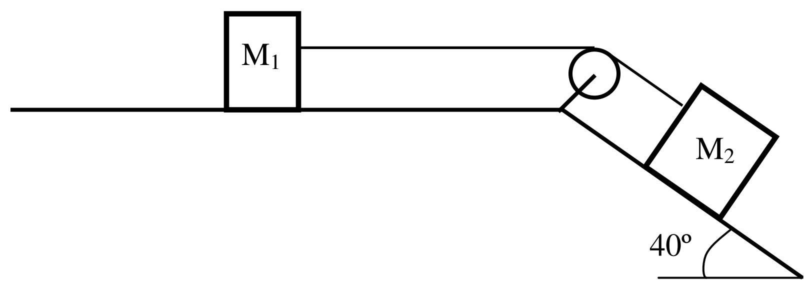
(a) What should be the minimum angle of the incline in order to have the block slipping down?
(b) If the angle of the incline plane is 30°, calculate the work done by the frictional force when the block slides down the incline a distance of 3 m.
(c) What is the work done by the gravitational force during the 3-m downward displacement?
(d) What is the minimum external force parallel to the surface of the incline plane that will start the block moving up the incline? Assume a 30° incline plane.



(a)	(b)	(c)	(d)

2. The figure below shows a block of mass $M_2 = 4$ kg on a frictionless plane inclined at angle $\theta = 40°$. It is connected by a cord of negligible mass to a block of mass $M_1 = 1$ kg on a horizontal frictionless surface. The pulley is frictionless and massless. Calculate:

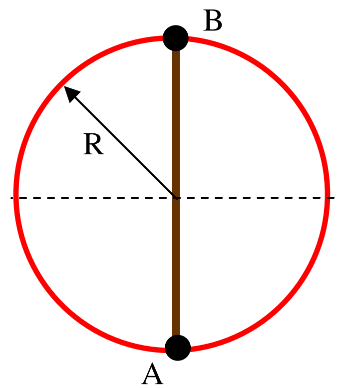
(a) Magnitude of the normal forces on each block.
(b) Acceleration of the boxes.
(c) Tension in the connecting cord.



(a)	(b)	(c)

3. A 1.5 kg stone attached to the end of a non-elastic cord describes a vertical circular trajectory of 2 m radius. When the stone is at its highest point, the tension in the cord T_B =20 N. Calculate: (Use Newton second law and energetic considerations).

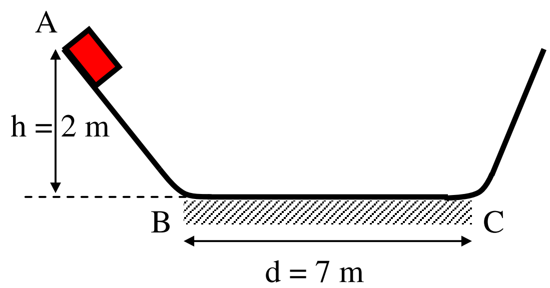
(a) Magnitude of the stone's velocity at B
(b) Magnitude of the stone's velocity at A
(c) Tension on the cord at A.



(a)	(b)	(c)

4. A block is released from rest at height h = 2m and slides down a frictionless ramp onto a plateau, which has a length d = 7 m and where the coefficient of kinetic friction is 0.4.

(a)What is the block's speed at the end of the incline plane (B)?
(b)Can the block reach the plateau's end (C)? If the block cannot reach C, how far from B will it stop? If it does, how far up the incline plane will it travel?



(a)	(b)

Formula sheet **PHY 2048**

$\vec{v} = \vec{v}_0 + \vec{a}t$

$\vec{r} = \vec{r}_0 + \vec{v}_0 t + 0.5\vec{a}t^2$

$v^2 = v_0^2 + 2a(x - x_0)$

$\vec{F} = m \cdot \vec{a}$

$F_s = -kx$

$a_c = \frac{v^2}{r}$

$E_{mec} = K + U$

$W_{net} = \Delta K$

$W_{net} = -\Delta U$

$\Delta E = \Delta K + \Delta U$

$\Delta E = \Delta K + \Delta U + \Delta E_{th}$

$\Delta E_{th} = f_k d$

$U(y) = mgy$

$U(x) = \frac{1}{2}kx^2$

$K = \frac{1}{2}mv^2$

$\vec{p} = m\vec{v}$

$\vec{F}_{ext} = \frac{d\vec{p}}{dt}$

$\vec{F}_{ext} = M\vec{a}_{COM}$

$\vec{a}_{COM} = \frac{d^2\vec{R}_{COM}}{dt^2}$

$\vec{R}_{COM} = \frac{1}{M_{tot}}\sum_i m_i \vec{r}_i$

$\vec{R}_{COM} = \frac{1}{M_{tot}}\int_V \vec{r}\, dm$

$\tau = I\alpha = r_\perp F = rF_\perp$

$s = \theta \cdot r$

$\omega = \omega_0 + \alpha \cdot t$

$a_t = \alpha \cdot r$

$K_{rot} = \frac{1}{2}I\omega^2$

$K_{tot} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$I = \sum_i m_i r^2$

$I = \int r^2\, dm$

$I = I_{COM} + Mh^2$

$a_r = \frac{v^2}{r} = r\omega^2$

$I_{disk} = \frac{1}{2}mR^2 = I_{cylinder}$

$I_{ring} = mR^2$

$I_{sphere} = \frac{2}{5}mR^2$

$Rv_{rel} = Ma$

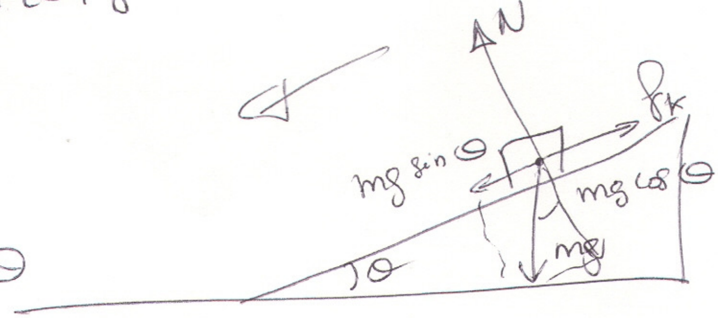
$v_f - v_i = v_{rel}\ln\frac{M_i}{M_f}$

MIDTERM 2 — PHY2048

[1] $m = 0.2\ kg$

$\mu_k = 0.2$

$f_k = \mu_k \cdot N = \mu_k mg\cos\theta$



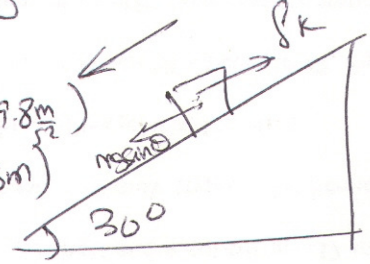
(a) $\sum_i F_i = m\cancel{a} = mg\sin\theta_{min} - f_k$

$0 = \cancel{mg}\sin\theta - \mu_k \cancel{mg}\cos\theta$

$\sin\theta = \mu_k \cdot \cos\theta \Rightarrow \tan\theta = \mu_k = 0.2 \rightarrow \boxed{\theta_{min} = 11.3°}$

(b) $W_{f_k} = \vec{f_k} \cdot \vec{d} = f_k \cdot d\cos 180°$

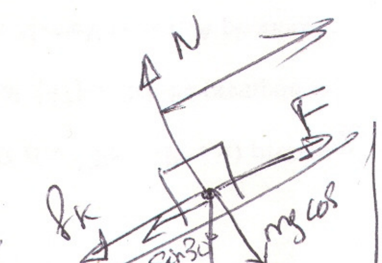
$W_{f_k} = -\mu_k mg\cos\theta\, d = -(0.2)(0.2)(9.8\frac{m}{s^2}) \cdot \cos 30° \cdot (3m)$



$\boxed{W_{f_k} = -1.02\ J}$ *

(c) $W_{mg} = +mg\sin\theta \cdot d = \boxed{2.94\ J}$

(d) $F - f_k = m \cdot a$



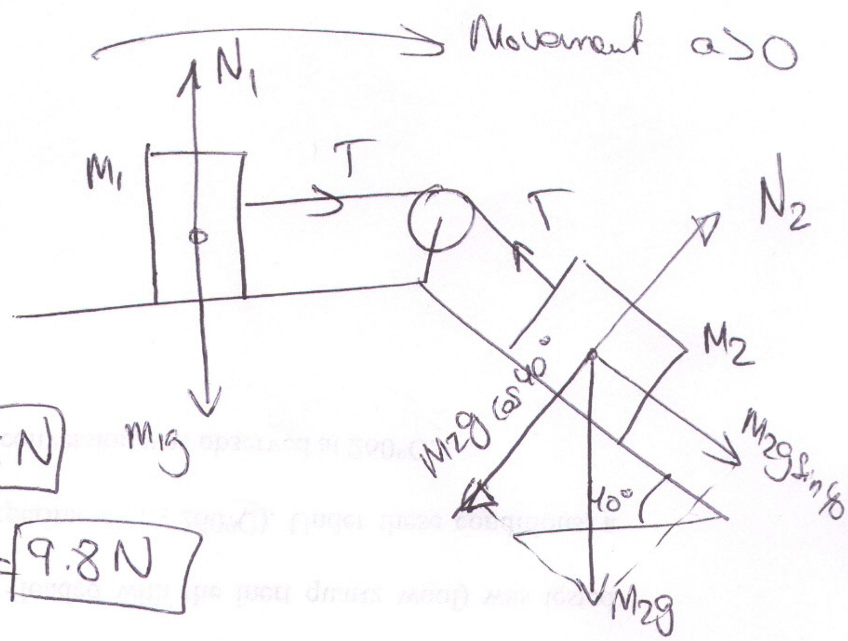
$F - \mu_k mg\cos 30° - mg\sin 30° = m \cdot \cancel{a}^{\,0}$ (V = cte)

$F = \mu_k mg\cos 30° + mg\sin 30° = \boxed{1.32\ N}$

(2) $M_2 = 4\,kg$

$M_1 = 1\,kg$

No friction



(a)

(1) $T = M_1 \cdot a = 1\,kg \cdot a = \boxed{5\,N}$

$N_1 = m_1 g = (1\,kg)(9.8\,\frac{m}{s^2}) = \boxed{9.8\,N}$

(2) $M_2 g \sin 40^\circ - T = m_2 a$

$N_2 = m_2 g \cos 40^\circ = (4\,kg)(9.8\,m/s^2)\cos 40^\circ = \boxed{30\,N}$

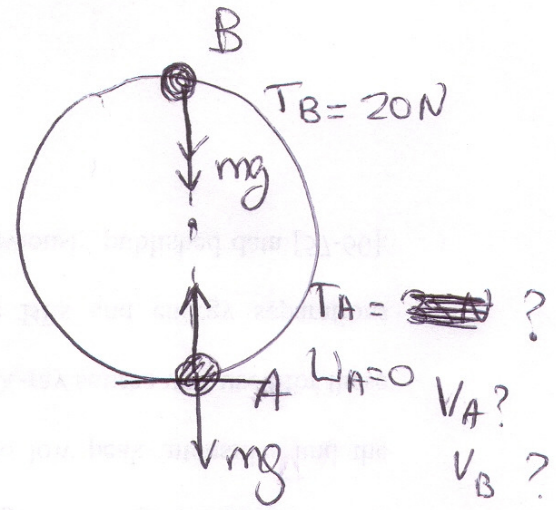
$T = a$ (1)

$+ \quad 25.2 - T = 4a$ (2)

$25.2 = 5a \rightarrow \boxed{a = 5\,m/s^2}$

(3) $m = 1.5\ kg$

$R = 2m$



$$F_c = m\frac{V_B^2}{R} = T_B + mg \quad (1)$$

$$F_c = m\frac{V_A^2}{R} = T_A - mg \quad (2)$$

(1) $0.75 V_B^2 = 20 + 14.7 = 34.7 \rightarrow V_B = \sqrt{\frac{34.7}{0.75}} = \boxed{6.8 \frac{m}{s}}$

(2) $0.75 V_A^2 = T_A - 14.7$

(3) $\Delta E = 0 = \Delta K + \Delta U = K_B - K_A + U_B - U_A$

$$\boxed{0 = \frac{1}{2} m (V_B^2 - V_A^2) + mg\,2R}$$

(3) $\boxed{0 = 0.75 V_B^2 - 0.75 V_A^2 + 58.8} \rightarrow 0 = 93.5 - 0.75 V_A^2$

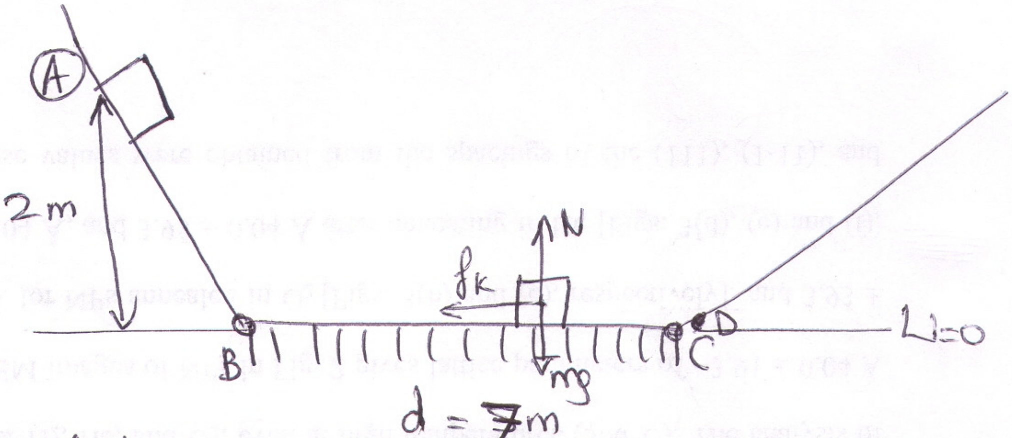
$$\downarrow$$

$$V_A = \sqrt{\frac{93.5}{0.75}} = \boxed{11.16 m/s}$$

(2) $0.75 V_A^2 = T_A - 14.7$

(2) $T_A = 14.7 + 0.75 V_A^2 = 14.7 + 0.75 (11.16)^2 = \boxed{108.2N}$

④ $\mu_K = 0.4$



V_B ?

(a) $\Delta E = 0 = \Delta K + \Delta U_g$

A–B $0 = K_B - \cancel{K_A} + \cancel{U_B} - U_A \Rightarrow K_B = U_A$

$\frac{1}{2}\cancel{m} v_B^2 = \cancel{m} g h \Rightarrow V_B = \sqrt{2gh} = \boxed{6.26\ m/s}$

(b) Does block reach C ? NO (L)

Let's assume YES ⇒ See how far the block can travel on region with friction. If $L > d$ ⇒ yes, block reach C

$\Delta E = 0 = \Delta K + \Delta U_g + \Delta E_{th}$

$0 = \cancel{K_D} - K_B + \cancel{U_D - U_B} + f_K \cdot L \Rightarrow K_B = f_K \cdot L = \mu_K \cdot mg\, L$ (with $f_K = \mu_K \cdot N$)

$\frac{K_B}{m} = \frac{1}{2}\cancel{m} v_B^2 = \mu_K \cancel{m} g L \Rightarrow 19.59 = 3.92 L \Rightarrow L \simeq 5m$

Max distance the block can travel ⇒ Block does not make it to C