UNIVERSITY OF GAZIANTEP
DEPARTMENT OF ENGINEERING PHYSICS
EP 105 General Physics I
Second Midterm Exam *SUMMER SCHOOL*

Date: 01/08/2019 Time: 13:30 Duration: 90 min.

Ques.	Mark
1	
2	
3	
4	
5	
Total	

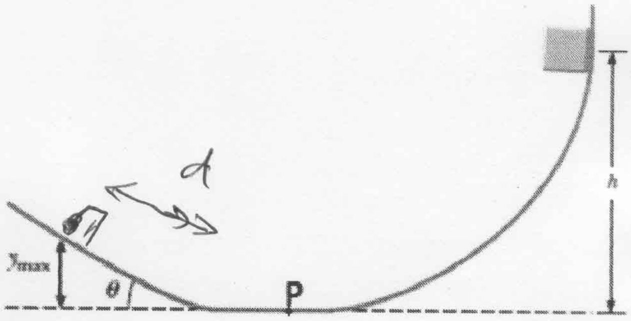
DEPARTMENT : CE ☐ MME ☐ IE ☐ ME ☐ TE ☐

Name	Surname	Student No	Signature

- Cheating is a serious offence and may lead to your dismissal from the university.
- Ignore air resistance in all problems unless otherwise stated.
- Write clearly your solutions steps to the space provided and results to the boxes.
- Constants: $g = 9.8\ m/s^2$, $\pi = 3.141593$
- Conversions: $1\ g = 10^{-3}\ kg$, $1\ cm = 10^{-2}\ m$, $1\ km = 10^3\ m$, $1\ h = 3600\ s$, $1\ min = 60\ s$, $1\ rev = 2\pi\ rad$.

QUESTION 1 (20 %)

A block of mass $2.0\,kg$ slides down a curved frictionless track from a height $h = 1.2\,m$ and then up an inclined plane with an angle $\theta = 37^0$ as in figure. The coefficient of kinetic friction between the block and the incline is $\mu_k = 0.4$.



(a) What is the kinetic energy of the block at point P?

$$K_p = \frac{1}{2} m v_p^2 = mgh$$
$$= (2)(9.8)(1.2)$$
$$= 23.52\ J$$

$$\boxed{K_p = 23.52\,J}$$

(b) What is the maximum height y_{max} that is reached by the block?

$$\frac{1}{2} m v_p^2 = mg\,y_{max} + \mu_k (mg\cos\theta)\, d$$
$$K_p = mg\,y_{max} + \mu_k \left(mg \frac{y_{max}}{\tan\theta} \right) = \left[1 + \frac{\mu_k}{\tan\theta} \right] mg\,y_{max}$$

Solving for y_{max}:

$$y_{max} = \frac{K_p}{[1+\mu_k/\tan\theta]mg} = 0.78\ m$$

$$\boxed{y_{max} = 0.78\,m}$$

QUESTION 2 (20 %)

An object is rotating with an initial speed of 48 m/s on a circular track of diameter 2.4 km. The object slows down with a constant angular acceleration of -2×10^{-4} rad/s^2. Find

a) the time required to take for the object to come to a stop, and

$$W_0 = \frac{v}{r} = \frac{48\ m/s}{2.4\times10^3/2} = 4\times10^{-2}\ rad/s$$

$$t = \frac{W - W_0}{\alpha} = \frac{0 - 4\times10^{-2}}{-2\times10^{-4}} = 200s$$

$$\boxed{t = 200\ s}$$

b) the number of revolutions around the track the object makes before coming to a stop.

$$W^2 = W_0^2 + 2\alpha\theta$$

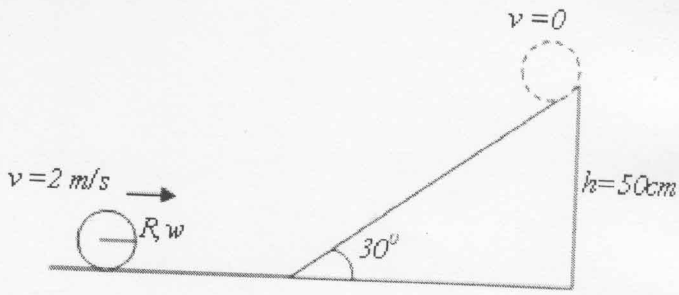
$$0 = [4\times10^{-2}]^2 + (2)(-2\times10^{-4})\,\theta \Rightarrow \theta = 4 rad.$$

$$\theta = 4\ \cancel{rad}\ \frac{1\ rev}{2\pi\ \cancel{rad}} = 0.64\ rev.$$

$$\boxed{\theta = 0.64\ rev.}$$

QUESTION 3 (20 %)

A bowling ball of radius $R = 20$ cm and mass $m = 10kg$ is rolling without slipping up a hill to a height $50\ cm$ before momentarily coming to rest. If the initial speed of ball (at t=0 s) is $2\ m/s$, find



(a) the moment of inertia of the ball (I) about its center of mass, and

CoE: $E_i = E_f$

$$\frac{1}{2}mv^2 + \frac{1}{2}IW^2 = mgh$$

$$\frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{R^2} = mgh$$

$$\frac{1}{2}(10)(2)^2 + \frac{1}{2}I\left(\frac{2}{0.2}\right)^2 = (10)(9.8)(0.5)$$

Solving for I:

$$I = 0.58\ kg.m^2$$

$$\boxed{I = 0.58\ kg.m^2}$$

(b) the angular momentum (L) of the ball at $t = 0\ s$.

at $t=0$ $\quad W = \frac{v}{r} = \frac{2\ m/s}{0.2\ m} = 10\ rad/s$

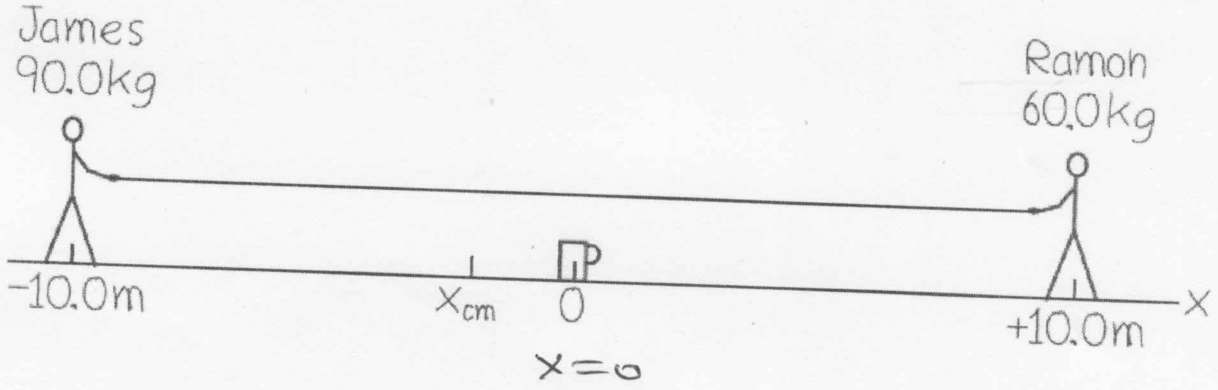
$$L = IW = (0.58)(10)$$

$$= 5.8\ kg.m^2/s$$

$$\boxed{L = 5.8\ kg.m^2/s}$$

QUESTION 4 (20 %)

James (mass m_1= 90.0 kg) and Ramon (mass m_2 = 60.0 kg) are 20.0 m apart on a icy surface. Midway between them is a cup of their tea. They pull on the ends of a light rope stretched between them.



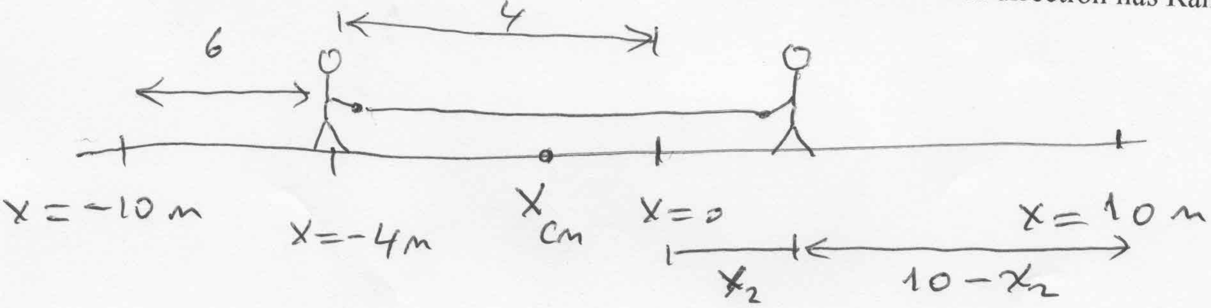
(a) Where is the center of mass of them (X_{cm}=?)?

$$X_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{(90)(-10) + (60)(10)}{90 + 60}$$

$$= -2 \text{ m}$$

$X_{cm} = -2$ m

(b) When James has moved 6.0 m <u>toward</u> the cup of tea, how far and in what direction has Ramon moved?



since there is no external force on the system, center of mass does not change. Therefore:

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$$

$$-2 = \frac{(90)(-4) + (60)(x_2)}{90 + 60}$$

9 m
toward James.

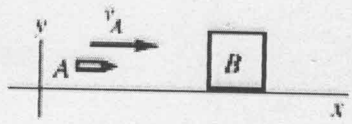
or toward cm.

Solving for $x_2 = 1$ m

Hence Ramon moved toward James 9 m

QUESTION 5 (20 %)

A 3.5 g bullet is fired horizontally into a 1.5 kg wooden block resting on a horizontal surface. The coefficient of kinetic friction between the block and surface is 0.20. The bullet remains embedded in the block, which is observed to slide 0.150 m along the surface before stopping. What is the initial speed of the bullet?



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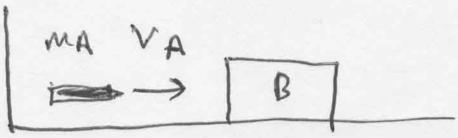

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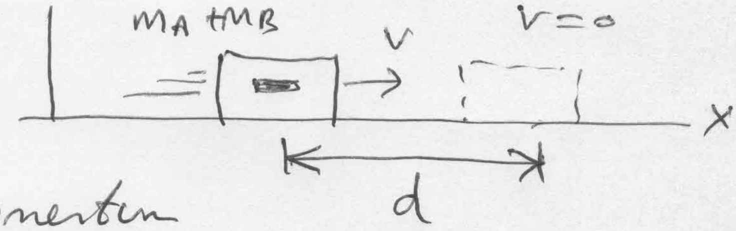

- Conservation of momentum

$$m_A V_A = (m_A + m_B)\, V \qquad (1)$$

- Conservation of Energy:

$$K_i + U_i + W_f = K_f + U_f \qquad (2)$$

$W_f \equiv$ workdone by friction

$$W_f = f_k d \cos 180^\circ = -\mu N d = -\mu (m_A + m_B) g d$$

$$\frac{1}{2}(m_A + m_B) V^2 + 0 - \mu (m_A + m_B) g d = 0 + 0$$

Solving for v:

$$v = \sqrt{2 \mu g d} = \sqrt{(2)(0.2)(9.8)(0.23)} = 0.95 \text{ m/s}$$

using eqn (1)

$$V_A = \left(\frac{m_A + m_B}{m_A}\right) V = \left(\frac{5\times10^{-3} + 1.2}{5\times10^{-3}}\right) 0.95 = 229 \frac{m}{s}$$

$$\boxed{V_A = 229 \text{ m/s}}$$