BITS Pilani, Dubai Campus
Dubai International Academic City, Dubai.

SECOND SEMESTER : 2013 – 2014

COMPREHENSIVE EXAMINATION (CLOSED BOOK)

Course Code:	**PHY F111**	Date:	**01.06.2014**
Course Title:	**Mechanics, Oscillations and Waves**	Maximum Marks:	**80**
Duration:	**3 hours**	Weightage:	**40%**

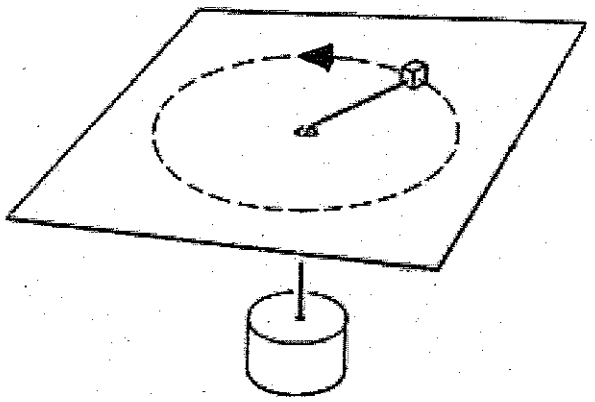
INSTRUCTIONS:

A) There are three parts in the question paper: PART - A, PART - B and PART - C. Each part has to be answered in SEPARATE ANSWER BOOKS.
B) Answer ALL questions.
C) Use $g = 9.8\ ms^{-2}$ where ever necessary and g acts vertically downwards.
D) Draw a rough sketch / free body diagram at all the suitable places.
E) The paper consists of 12 questions in 4 pages.

PART - A

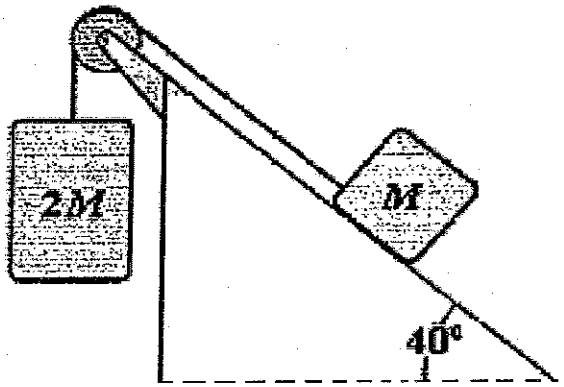
Q1. An air puck of mass 0.25 kg is tied to a string and allowed to revolve in a circle of radius 1.0 m on a frictionless, horizontal table. The other end of the string passes through a hole in the centre of the table and a mass of 1.25 kg is tied to it as shown below. The suspended mass remains in equilibrium while the puck on the tabletop revolves. In this situation, find (a) the tension in the sting, (b) the speed of the puck and (c) frequency of rotation of the puck.

[2M+2M+2M]

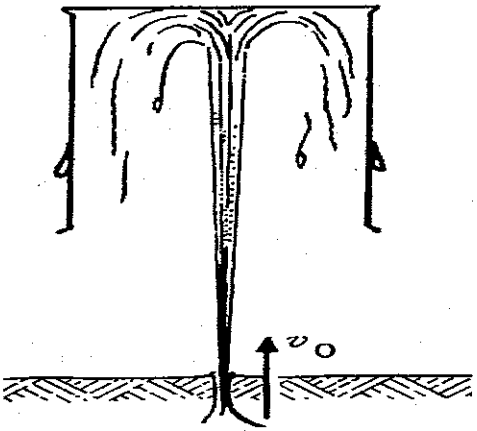


Q2. An instrument-carrying projectile accidentally explodes at the top of its trajectory. The horizontal distance between the launch point and the point of explosion is L. The projectile breaks into two pieces which fly apart horizontally. The larger piece has three times the mass of the smaller piece. To the surprise of the scientist in-charge, the smaller piece returns to earth at the launching station. How far away does the larger piece land? Neglect air resistance and effects due to the earth's curvature. **[4M]**

Q3. In the figure shown the coefficient of kinetic friction between the block and the inclined plane is 0.4. Find the magnitude of the acceleration of the suspended block as it falls. Also find the tension in the string. Assume the frictionless and massless pulley. **[10M]**



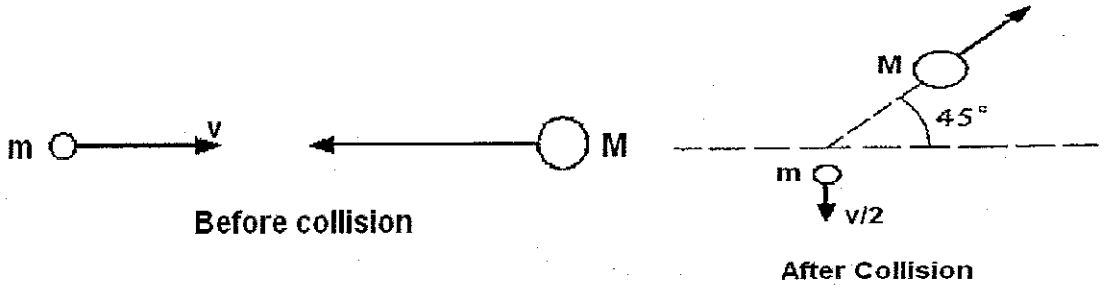
Q4. An inverted garbage can of mass 10 kg is suspended in air by water from geyser. The water shoots up from the ground with speed 20 ms^{-1}, at a constant rate of 6 kgm^{-1}. Find the maximum height at which the garbage can rides. **[6M]**



PART - B

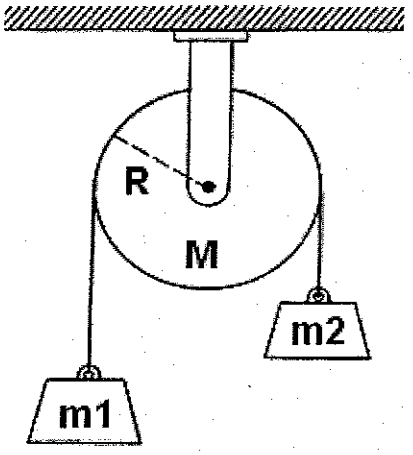
Q5. A mass m is shot vertically upward from the surface of the earth with an initial velocity v. If gravity is the only force acting on it, find the maximum altitude reached by the mass. Also estimate the minimum value of v for the mass to escape from the influence of the earth's gravity. Assume mass to be M and radius to be R for the earth. **[8M]**

Q6. A particle of mass m and initial velocity v collides elastically with a particle of mass M coming from the opposite direction as shown below. After the collision, m has a velocity half of its initial value at right angles to the initial direction. If the other mass M moves off as shown below, find the ration of M and m. **[8M]**

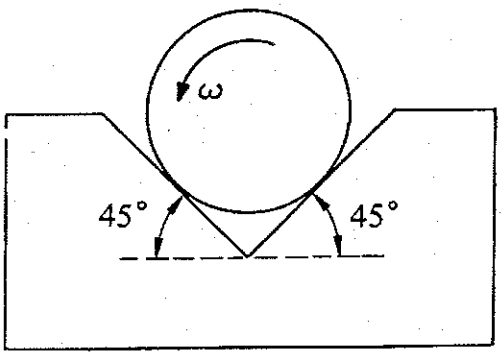


Q7. Two masses m_1 and m_2 are attached to a string via pulley of mass M and radius R, as shown below. Assume $m_2 < m_1$. Find the acceleration of the mass-pulley system.

[8M]



Q8. A cylinder of weight 100 N and radius 0.1 m is rotated in a uniform V groove (as shown below) with constant angular velocity ω. The coefficient of friction between the cylinder and each surface is 0.5. Obtain the value of the torque that must be applied to the cylinder to keep it rotating. **[6M]**



PART – C

Q9. The equation of a transverse wave travelling along a sting is given by 0.3 Sinπ(0.5x-50t), where y and x are in centimeters and t in seconds.

(a) Find the amplitude, wavelength, frequency, velocity of the wave and the direction of propagation.

(b) Find the maximum transverse speed of any particle in the string and the transverse displacement at x = 3.5 cm when t = 0.26 s. **[4M+4M]**

Q10. The motion of ripples of short wavelength approximately 1 cm wavelength on water is controlled by surface tension. The phase velocity of such ripples is given by $v_p = \sqrt{\left(\frac{2\pi S}{\rho\lambda}\right)}$, where S is the surface tension and ρ is the density of water. Find the ratio between the group velocity and the phase velocity. **[4M]**

Q11. A 50-g mass connected to a spring of force constant 35 N/m oscillates on a horizontal, frictionless surface with an amplitude of 4.0 cm. Find (a) the total energy of the system and (b) the speed of the mass when the displacement is 1.0 cm. **[3M+3M]**

Q12. The tiny distance between slits can be difficult to measure. But you can use the interference pattern to find the spacing. Suppose you illuminate the slits with 589-nm yellow sodium light and observe a 4.50-cm bright-fringe spacing on a screen 1.75 m away.

(a) What is the slit spacing?

(b) What is the angle for the first-order maximum? **[3M+3M]**

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I Year, SECOND SEMESTER : 2013 – 2014

TEST-2 (OPEN BOOK)

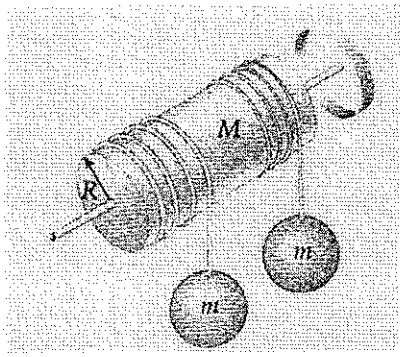
Course Code:	**PHY F111**	Date:	**30.04.2014**
Course Title:	**Mechanics, Oscillations and Waves**	Maximum Marks:	**40**
Duration:	**50 min.**	Weightage:	**20%**

INSTRUCTIONS:

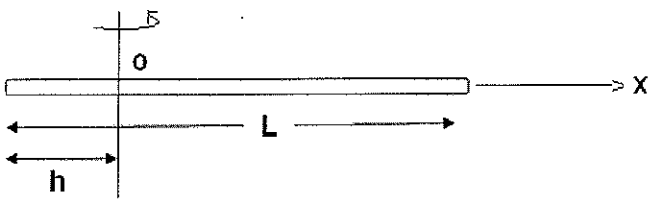
A) **Answer ALL the questions.**
B) **Use g = 9.8ms^{-2} where ever necessary and g acts vertically downwards.**
C) **Draw a rough sketch / free body diagram at all the suitable places.**
D) **The paper consists of 6 questions in 2 pages.**

Q1. A uniform solid cylinder of mass M and radius R rotates on a frictionless horizontal axle as shown in the figure below. Two objects with equal masses hang from identical light cords wrapped around the cylinder. Assume that the cords do not slip on the cylinder. If the system is released from rest, find,

a) The tension in each cord and
b) The acceleration of each object after the objects have descended a distance of h. **[8 M]**



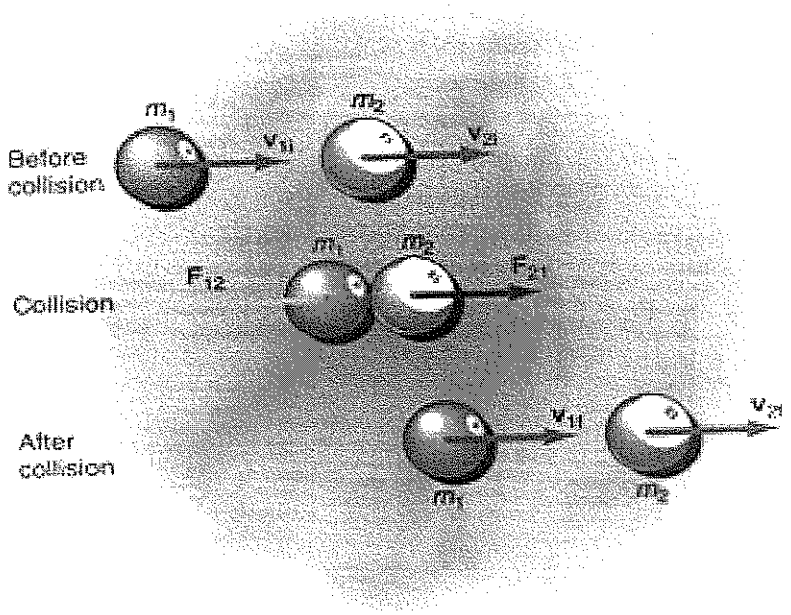
Q2. Find the moment of inertia of a slender rod with mass M and length L about an axis passing through O, as shown in the figure, at an arbitrary distance h from one end. **[4M]**



[PTO]

Q3. A 0.140 kg ball is thrown upward with an initial velocity of 35.0 m/s. Find the a) the total energy b) the maximum height of the ball and c) the kinetic energy and velocity of the ball at 30.0m. **[8M]**

Q4. Consider the perfectly elastic collision between masses m_1 = 100g and m_2= 200g. Ball 1 is moving with a velocity v_{1i} of 30.0cm/s to the right and the ball 2 has a velocity, v_{2i} = 20.0cm/s, also moving to the right, as shown in figure. Find the final velocities of the two balls. **[6M]**



Q5. A grind stone has a moment of inertia of 1.6 $x10^{-3}$ kgm^2. When a constant torque is applied, the flywheel reaches an angular velocity of 1200 revolutions perminute in 15 s. Assuming it started from rest, find (a) angular acceleration (b) the unbalanced torque applied (c) the angle turned through in 15 s (d) the work done on the flywheel by the torque and (e) the angular momentum after 15 s. **[10M]**

Q6. A mass attached to a horizontal spring oscillates with an amplitude of 10 cm at a frequency of 5 Hz. Find (a) Maximum speed of the mass and (b) speed when it is at a distance 5 cm. **[4M]**

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I Year, SECOND SEMESTER : 2013 – 2014

Course Code:	**PHY F111**	Date:	**05.03.2014**
Course Title:	**Mechanics, Oscillations and Waves**	Maximum Marks:	**50**
Duration:	**50 min.**	Weightage:	**25%**

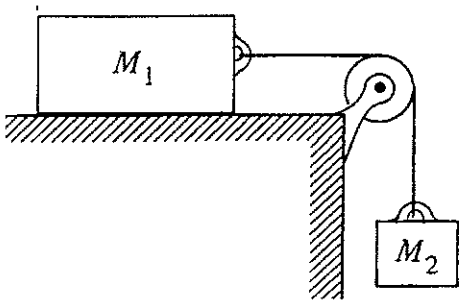
INSTRUCTIONS:

A) **Answer ALL the questions.**
B) **Use g = 9.8ms^{-2} where ever necessary and g acts vertically downwards.**
C) **Draw a rough sketch / free body diagram at all the suitable places.**
D) **The paper consists of 6 questions in 2 pages.**

01. (a) A particle moves outward along a spiral. Its trajectory is given by r = Aθ, where A is a constant and $A = \frac{1}{\pi}\text{mrad}^{-1}$. θ increases in time according to $\theta = \frac{\alpha t^2}{2}$, where α is a constant. Find the angle at which the radial and tangential accelerations have equal magnitude.

(b) Find a unit vector perpendicular to the both (2**i** + 3**j** – 2**k**) and (**k** – **i** + **j**). **[4M+4M]**

02. Two blocks of masses M_1 = 2kg and M_2= 3kg are attached to each other by means of a massless and inextensible string. They are placed on a rough horizontal surface. The coefficient of friction between the block M_1 and the surface is 0.4. Find (a) frictional force, (b) acceleration of the system, (c) tension in the string, (d) velocity of M_2 after 3 s and (e) If the string got cut after next 3 s, find the distance travelled by M_2 in the next 2 s. **[10M]**



03. Find the shortest possible period of revolution of two identical gravitating solid spheres which are in circular orbit, in free space about a point midway between them. **[6M]**

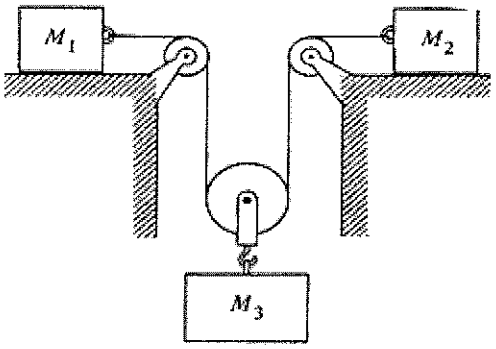
[PTO]

04. The system below uses massless pulleys and rope. The coefficient of friction between the masses and the horizontal surfaces is μ. Assume masses are sliding.

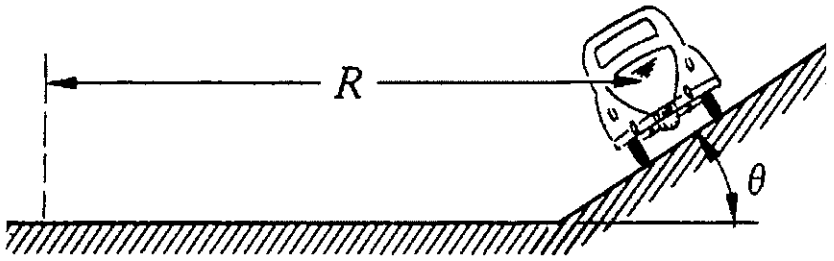
(a) Draw force diagrams and show all the relevant coordinates.

(b) Deduce a relation between the accelerations of the three masses.

(c) Determine the tension in the rope. **[3M+3M+4M]**



05. An automobile enters a turn whose radius is R. The road is banked at angle θ, and the coefficient of friction between wheels and the road is μ. Draw the force diagram and show all the forces acting on the automobile. Find the maximum and minimum speeds for the car to stay on the road without skidding sideways. **[10M]**



06. The density of a thin rod of length L varies with the distance x from one end as $\rho = \rho_0 \left[\frac{x^2}{L^2}\right]$.

Find the position of the centre of mass. **[6M]**

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