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

I Year, FIRST SEMESTER:2013 – 2014

COMPREHENSIVE EXAMINATION (CLOSED BOOK)

Course Code:	**PHY F111**	Date:	**07.01.2014**
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. Answer ALL questions.**

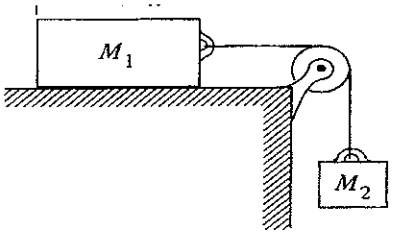
B) **Use g = 9.8 ms^{-2} where ever necessary and g acts vertically downwards.**

C) **Draw a rough sketch / free body diagram at all the suitable places.**

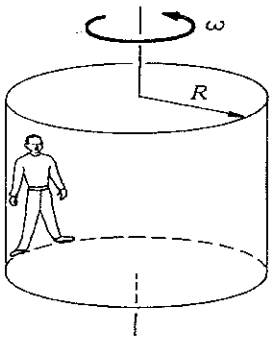
D) **The paper consists of 12 questions in 3 pages.**

PART - A

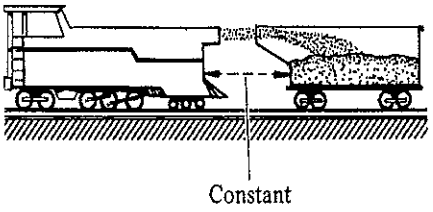
Q1. The two blocks shown in the sketch are connected by a string of negligible mass. If the system is released from rest, find how far the block M_1 slides in time t. Assume that the surface on which M_1 slides is frictionless. **[4M]**



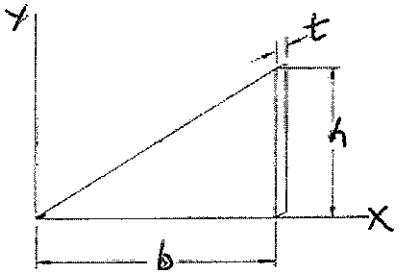
Q2. The Spinning terror is, an amusement park ride, of a large vertical drum which spins so fast that everyone inside stays pinned against the wall when the floor drops away. If the coefficient of friction between the vertical walls of the drum and the mass M is μ, what is the minimum frequency which allows the floor to be dropped away safely? **[6M]**



Q3. A sand-spraying locomotive sprays sand horizontally into a freight car as shown in the sketch. The locomotive and freight car are not attached. The engineer in the locomotive maintains his speed so that the distance to the freight car is constant. The sand is transferred a rate of 10 kg/s with a velocity of 5 m/s relative to the locomotive. If the car starts from rest with an initial mass of 2000 kg, find its speed after 100 s. **[8M]**



Q4. Find the centre of mass of the two dimensional uniform right angled triangular sheet of mass **M**, base **b**, height **h** and thickness **t**. **[10M]**

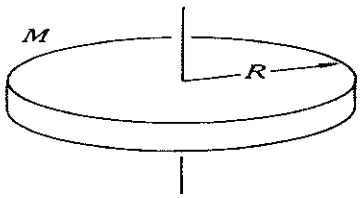


PART - B

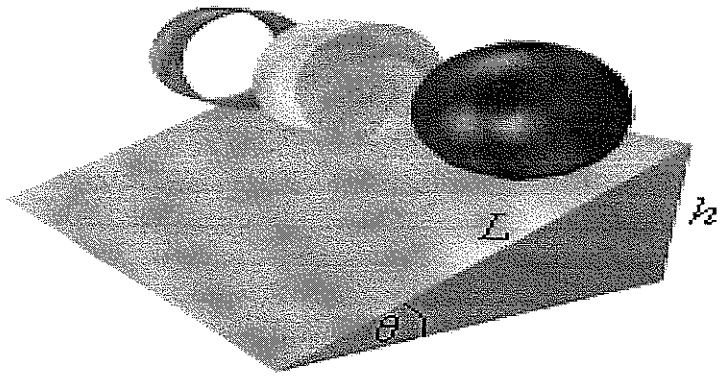
Q5. A sports car of mass 817 kg accelerates to 26.8 m/s in 8 s. What is the work done during this time? Also, what is the average power that the engine delivers to the car's motion during this period? **[4M]**

Q6. A cart with mass 0.340 kg moving on a frictionless linear air track at 1.2 m/s strikes a second cart of unknown mass at rest. The collision between the two carts is elastic. After the collision, the first cart continues in its original direction at 0.66 m/s.
(a) What is the mass of the second cart?
(b) What is the velocity of the second cart after impact? **[6M]**

Q7. Obtain an expression for the moment of inertia of a uniform disk of mass M, radius R about an axis through its centre and perpendicular to the plane of the disc. Using parallel axes theorem, find the moment of inertia of the disc about a tangential axis passing through a point on its circumference and lying in the plane of the disc. **[8M]**



Q8. A uniform ring, a uniform cylinder and a uniform sphere are released simultaneously from rest at the top of an inclined plane as shown below. Assume mass M and radius R for all the objects given. If they roll without slipping, determine their accelerations and state which body reaches the bottom of the inclined plane first. **[10M]**



PART – C

Q9. A wave of frequency 20 s^{-1} has a velocity of 80 ms^{-1}.
(a) How far apart are the two points whose displacements are 30^0 out of phase?
(b) At a given point, what is the phase difference between two displacements occurring at times separated by 0.01 s? **[2M+2M]**

Q10. A 120 cm guitar string is under a tension of 400 N. The mass of the string is 0.48 g.
(a) What is the linear density of the material of the guitar string?
(b) Calculate the speed of the wave in it.
(c) In a diagram show the number of ($\lambda/2$)s that appear in this string, if it is oscillating at a frequency of 2083 Hz. **[2M+2M+2M]**

Q11. **(a)** White light is passed through a slit and interference is observed on a screen 2.5 m away. The separation between slits is 0.5 mm. The first x-colored fringe is formed 3.5 mm away from the central fringe. Find the wavelength of that x-color?
(b) The intensity at the center of a single-slit diffraction pattern is I_0. What is the intensity at a point in the pattern where there is a 66-radian phase difference between wavelets from the two edges of the slit? **[3M+3M]**

Q12. A body of mass 0.2 kg is hung from a spring whose spring constant 80 N/m. The body is subjected to a resistive force given by bV, where V is the velocity in m/s. Calculate
(a) the value of the undamped frequency,
(b) the value of time constant τ, if the damped frequency is $\frac{1}{2}\sqrt{3}$ times of the undamped frequency and
(c) the quality factor Q of the system. **[2M+4M+2M]**

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

I Year, FIRST SEMESTER:2013 – 2014

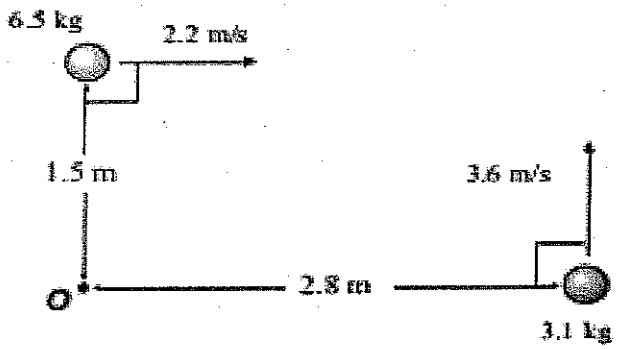
T E S T – 2 (OPEN BOOK)

Course Code:	**PHY F111**	Date:	**10.12.2013**
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.

01. Two objects are moving as shown in the diagram. Find their total angular momentum about O? **[4 M]**

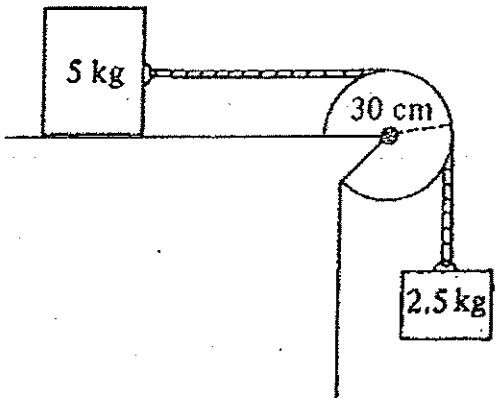


02. A hollow sphere of M and radius R is rotating about an axis passing through its centre. Find the moment of inertia of this sphere. Also find the moment of inertia of the same sphere about any tangential axis. **[10M]**

03. A bowling ball has a mass of 4.0 kg, a moment of inertia of 1.6×10^{-2} kgm^2 and a radius of 0.10 m. If it rolls down the lane without slipping at a linear speed of 4.0 m, find its total energy? **[3 M]**

[PTO]

04. The frictional force between the block and the table in the figure below is 20 N. If the moment of inertia of the wheel is 4 kgm^2, how long will it take the block to drop 60 cm after the system is released. Assume there is no slippage between the rope and wheel. **[10 M]**



05. A mass of 0.300 kg is placed on a vertical spring and the spring stretches by 10.0 cm. It is then pulled down an additional 5.00 cm and then released. Find a) the spring constant, b) the angular frequency ω, c) the maximum velocity of the vibrating mass and d) the maximum acceleration of the mass and e) the maximum restoring force. **[10M]**

06. A wheel is attached to a fixed shaft and the system is free to rotate without friction. To measure the moment of inertia of the wheel-shaft system a tape of negligible mass wrapped around the shaft and is pulled with a constant force of 16 N. When a length of 3 m is unwound the system is rotating at a rate of 1.5 rpm. Find the moment of inertia of the system. **[3M]**

---------- **END OF THE PAPER**----------

BITS PILANI, DUBAI CAMPUS
Dubai International Academic City, Dubai.

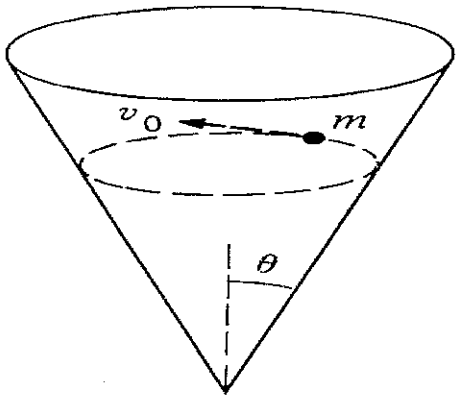
I Year, FIRST SEMESTER:2013 – 2014

Course Code:	**PHY F111**	Date:	**01.10.2013**
Course Title:	**Mechanics, Oscillations and Waves**	Maximum Marks:	**50**
Duration:	**50 min.**	Weightage:	**25%**

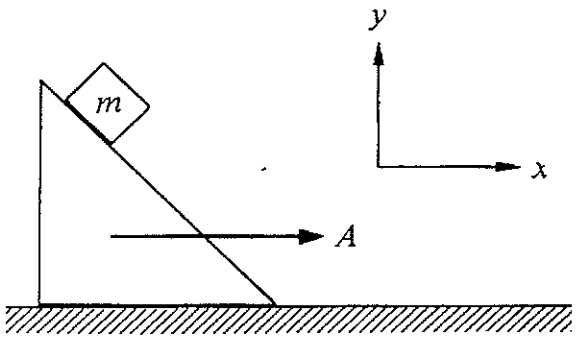
INSTRUCTIONS:

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 particle of mass m slides without friction on the inside of a cone. The axis of the cone is vertical. The apex half angle of the cone is θ, as shown in the diagram. If the speed of the particle is v_0, find the radius of the circular path in terms of v_0, g and θ. **[6 M]**

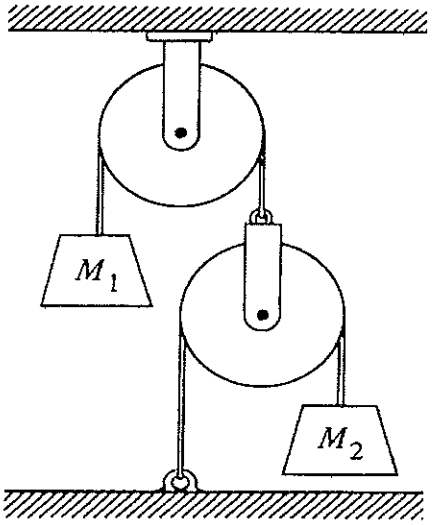


02. A 45^0 wedge is pushed along a table with constant acceleration **A**. A block of mass m slides without friction on the wedge as shown in the diagram. Find the acceleration of the block. **[10 M]**

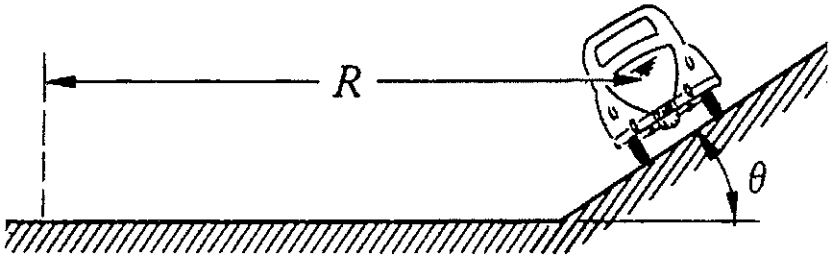


[PTO]

03. Masses M_1 and M_2 are connected to a system of strings that are massless and inextensible and the pulleys that are massless and frictionless as shown in the diagram. Find the acceleration of M_1. Also if the masses are equal find the acceleration of M_1. **[8 M]**



04. 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. Find the maximum and minimum speeds for the car to stay on the road without skidding sideways. **[12 M]**



05. A particle moves in a plane with constant radial velocity $\dot{r}$ = **4 ms^{-1}**. The angular velocity is constant and has a magnitude $\dot{\theta}$ = **2 rads^{-1}**. When the particle is 3 m from the origin, find its velocity and acceleration. **[6 M]**

06. A 5 kg mass moves under the influence of a force $(4t^2\,\mathbf{i} - 3t\,\mathbf{j})$N, where **t** is in seconds. It starts from origin at **t = 0**. Find its position and velocity. Also find **r** X **V** at **t = 1** s. **[8 M]**

---------- **END OF THE PAPER**----------

Set A

BITS Pilani, Dubai Campus

1st Year, FIRST SEMESTER:2013 – 2014

QUIZ - 1

Course Code:	**PHY F111**	Date:	**19.11.2013**
Course Title:	**Mechanics, Oscillations and Waves**	Maximum Marks:	**14**
Duration:	**20 minutes**	Weightage:	**7%**

Name of the student		**ID No.**	
Name of the faculty		**Section:**	

NOTE: Answer all questions. Take g=9.8 ms^{-2} wherever necessary. Write the answers in the space provided.

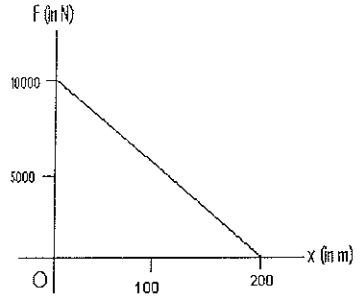
Q1. The potential energy of a particle in a region of space is U = $(3x^2 - Bx)$ J. where x,y and z are in meters. Find the value of B, if the force acting at (1,0,0) is 4 N. **[2M]**

Q2. Two particles of mass 10 g and 40 g are approaching each other with 3 ms^{-1} and 2 ms^{-1}. After collision, if the particles stick and move together, find their common velocity. **[2M]**

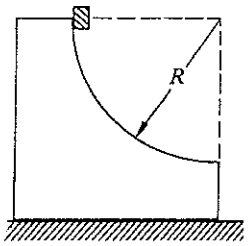
Q3. Calculate the work done by a force of $(2\mathbf{i} - \mathbf{j} + \mathbf{k})$ N if a particle of mass 100 g is displaced to $(\mathbf{i} + \mathbf{j} + \mathbf{k})$ m from $(3\mathbf{k} - 2\mathbf{i} - \mathbf{j})$ m. **[2M]**

Q4. A body of mass m kg is lifted by a man to a height of one metre in 30 sec. Another man lifts the same mass to the same height in 60 sec. Find the ratio of their power. **[2M]**

Q5. A 2000 Kg car accelerates from rest. The net force on the car as it travels from x = 0 m to x = 200 m is represented by graph given below. Find the speed of the car after travelling 200 m. **[2M]**



Q6. A small particle of mass 50 g slides down a circular path of radius 30 cm cut into a large block of mass 1 kg as shown below. Block and the particle move without friction. Initially both are at rest and particle starts from the top of the path. Find the velocity of the particle as it leaves the block. **[4M]**



Set B

BITS Pilani, Dubai Campus

1st Year, FIRST SEMESTER:2013 – 2014

QUIZ - 1

Course Code:	**PHY F111**	Date:	**29.10.2013**
Course Title:	**Mechanics, Oscillations and Waves**	Maximum Marks:	**16**
Duration:	**20 minutes**	Weightage:	**8%**

Name of the student		**ID No.**	
Name of the faculty		**Section:**	

NOTE: Answer all questions. Take g=9.8 ms^{-2} wherever necessary. Write the answers in the space provided.

Q1. A 6 kg sled is coasting on frictionless ice at a speed of 9 ms^{-1} when a 12 kg package is dropped into it from above. What is the new speed of the sled? **[2M]**

Q2. The rocket ejects gas at a constant rate of 9000 kg per minute with a constant speed 1600 ms^{-1} relative to the rocket. What is the thrust produced by the rocket? **[2M]**

Q3. A 50 kg woman jumps straight into air, rising from the ground. What impulse does she receive from the ground to attain this height? **[2M]**

Q4. Water shoots out of a fire hydrant having nozzle radius r nozzle speed V. What is the reaction force on the fire hydrant? **[2M]**

Q5. A projectile shot with a speed V at an angle θ to the horizontal, explodes into two pieces at its maximum height. The larger piece has three times the mass of the smaller piece. The horizontal distance between the launch point and the exploding point is 21 m. If the smaller piece returns to the point of projection, how far away does the larger piece land? **[3M]**

Q6. Two point masses 2 kg and 3 kg are placed 10 cm apart. Find the distance of centre of mass of the system from 2kg mass. **[2M]**

Q7. Find the centre of mass of a rod of length L which has a non uniform density. λ , the mass per unit length of the rod varies as $\lambda = \lambda_0\left(\frac{x}{L}\right)$, where λ_0 is a constant and x is the distance from one end. **[3M]**