BITS, PILANI – DUBAI
International Academic City, Dubai
I-Year I-Semester 2010-11
Comprehensive Examination

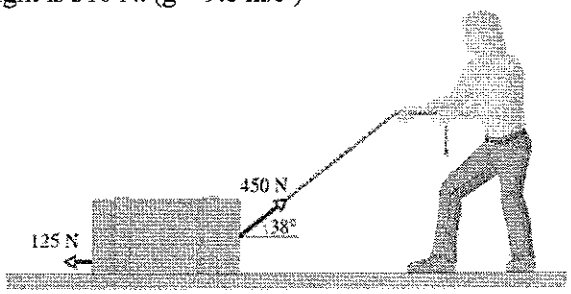
Course Name:	Physics I;	**Course No.:**	PHY C131;
Date:	23-12-10;	**Weightage:**	40%;
Duration.:	3hrs;	**Max Marks:**	120

Section A

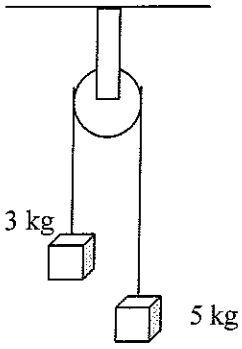
1. A worker drags a crate across a factory floor by pulling on a rope tied to the crate as shown in the figure. The worker exerts a force of 450 N on the rope, which is inclined at 38° to the horizontal and the floor exerts a horizontal force of 125 N that opposes the motion. Calculate the magnitude of the acceleration of the crate if

(a) its mass is 310 kg and

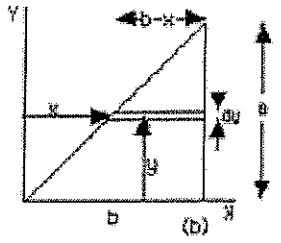
(b) its weight is 310 N. ($g = 9.8\ m/s^2$) (10)



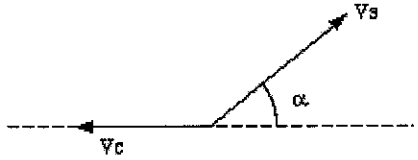
2. Two masses of 3.00kg and 5.00 kg are connected by a light string that passes over a frictionless massless pulley as shown. Determine a) the tension in the string, b) the acceleration of each mass and c) the distance each mass will move in the first second of the motion if both masses start from rest. (10)



3. A thin uniform object of mass M in the shape of a right triangle with altitude a and base b is shown in fig. below. Find the center of mass coordinate (Y_{cm}) of the triangle taking the section of dm as shown below. (10)

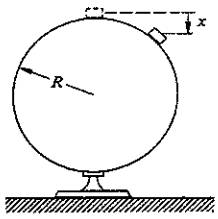


4. A 1400 kg cannon fires a 70 kg shell with a muzzle speed of 556 m/s at an angle of 39° above the horizontal. The cannon is mounted on frictionless rails, so that it recoils freely.
(a) What is the speed of the shell with respect to the ground.
(b) What is the impulse experienced by cannon gun. (10)

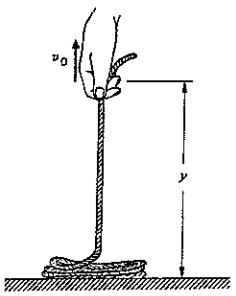


Section B

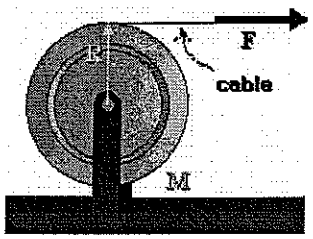
5. A block of mass 'm' starts from rest and slides down the surface of a frictionless solid sphere of radius 'R' as shown in the diagram. Find the angle at which the mass flies off the sphere. Also find its radial and tangential accelerations as a function of angle. (6+2+2=10)



6. A uniform rope of mass 'λ' per unit length is coiled on a smooth horizontal table. One end is pulled straight up with constant speed 'v_0'. (a) Find the force exerted on the end of the rope as a function of height 'y'. (b) compare the power delivered to the rope with the rate of change of rope's total mechanical energy. (5+5=10)



7. A cable is wrapped around a uniform, solid cylinder of radius 'R' and mass 'M'. The cylinder rotates about its axis, and the cable unwinds without stretching or pulling. If the cable is pulled with a force of 'F' Newtons, what is its acceleration? (10)



8. A uniform sphere of mass M and radius R and a uniform cylinder of mass M and radius R are released simultaneously from rest at the top of an inclined plane. Which body reaches the bottom first if they both roll without slipping? (10)

Section C

9. A mass of 0.300kg is placed on a vertical spring and the spring stretches by 10.0cm. It is then pulled down an additional 5.00cm and then released. Find a) the spring constant k, b) the angular frequency ω, c) the frequency f, d) the period T, e) the maximum velocity of the vibrating mass, f) the maximum acceleration of the mass, g) the maximum restoring force. (7 x 2 = 14)

10. The motion of ripples of short wavelength (≤ 1 cm) on water is controlled by surface tension. The phase velocity of such ripples is given by

$$v_p = \left(\frac{2\pi S}{\rho\lambda}\right)^{\frac{1}{2}}$$

where S is the surface tension and ρ the density of water.
a) Show that the group velocity for a disturbance made up of wavelengths close to a given λ is equal to $3v_p/2$.
b) If the group consists of two waves, of wavelengths 0.99 and 1.01cm, what is the distance between crests of the group? (10)

11. Light from a sodium vapor lamp (589nm) forms an interference pattern on a screen 0.8m from a pair of slits. The bright fringes in the pattern are 0.35cm apart. What is the slit separation. (8)

12. A parallel beam of light of wavelength 5000Å falls on a narrow slit and fraunhofer diffraction pattern is received on a screen 1m away from the slit. If the width of the slit is 0.2mm, find the distance of the first minimum from the centre of the screen. (8)

BITS, PILANI – DUBAI
International Academic City, Dubai
I-Year I-Semester 2010-11
Test II (Open Book)

Course Name:	Physics I;	**Course No.:**	PHY C131;
Date:	11-11-10;	**Weightage:**	20%;
Duration.:	50 minutes;	**Max Marks:**	60

1. Find the COM of two uniform rods of length l_1 and l_2 and mass m_1 and m_2 respectively placed in a shape of an " L ". Let λ be the linear mass density of both rods. The intersection of the rods co-incides with the origin of the co-ordinate system. (10)

2. Calculate the impulse experienced when a 70kg person lands on firm ground after jumping from a height of 3.0 m. Estimate the average force exerted on the person's feet by the ground if the landing is stiff legged assuming the body is in contact with the ground for a time interval of 2.6 ms. ($g = 9.8$ m/.s^2) (10)

3. A rocket at rest in space, where there is virtually no gravity, has a mass of 2.55×10^5 kg, of which 1.81×10^5 kg is fuel. The engine consumes fuel at the rate of 480 kg/s and the exhaust speed is 3.27 km/s. The engine is fired for 250 s.

i) Find the thrust of the rocket engine.
ii) What is the mass of the rocket after the engine burn?
iii) What is the final speed attained? (10)

4. A sand bag of mass 10 Kg is suspended with a 3 meter long weightless string. A bullet of mass 200gm is fired with a speed of 20m/sec into the bag and stays in the bag. Calculate
(a) the speed acquired by the bag after the collision
(b) the maximum height attained by the bag after the collision
(c) energy converted to heat in the collision (10)

5 A block of mass m is fired up an inclined plane at an angle θ with an initial velocity v_0. It travels a distance d up the plane, comes momentarily to rest, and then slides back down to the bottom of the plane. What is the magnitude of the kinetic friction force that acts on the block while it is moving? What will the velocity be when the block returns at its original position? (10)

6. A particle of mass ***2 Kg*** collides with a second particle of mass ***3 Kg***. Before the collision, the first particle is moving in the *x*-direction with a speed *10 m/s* and the second particle is moving at an angle of *30°* with the x-direction at a speed of *25 m/s*. After the collision, the two masses stick together and move.
(a) Find the velocity of the two particles after the collision. (*ie* find the *x*- and *y*-components of the velocity.) and the angle at which they move after collision (with respect to the x-direction)
(b) Find the total kinetic energy of the two particles before and after the collision.
(c) Is the collision elastic or inelastic? (10)

BITS, PILANI – DUBAI
International Academic City, Dubai
I-Year I-Semester 2010-11
Test I (Closed Book)

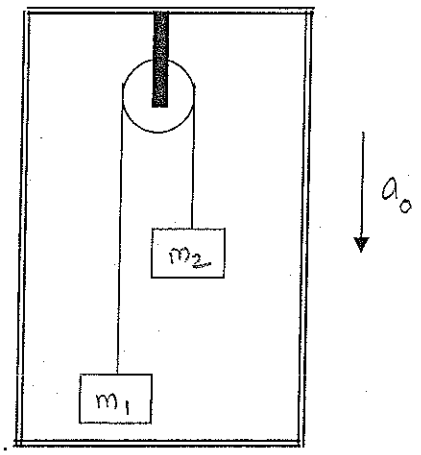
Course Name:	Physics I;	**Course No.:**	PHY C131;
Date:	03-10-10;	**Weightage:**	25%;
Duration.:	50 minutes;	**Max Marks:**	75

Q1.Blocks with masses of 4.0 kg, 8.0 kg, and 9.0 kg are lined up in a row on a frictionless table. All three are pushed forward by a single 15 N force applied to the 4.0 kg block. Draw the free body diagram for all the blocks.

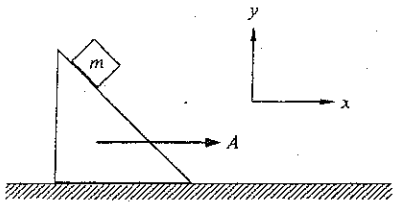
a) How much force does the 8.0 kg block exert on the 9.0 kg block?
b) How much force does the 8.0 kg block exert on the 4.0 kg block? (12)

Q2.Figure shows an Atwood's machine mounted inside a lift. The masses of the blocks are $\mathbf{m_1 = 4.20\ kg}$, $\mathbf{m_2 = 2.80\ kg}$. The lift has a downward acceleration of $\mathbf{a_0 = 2.48\ m/s^2}$.

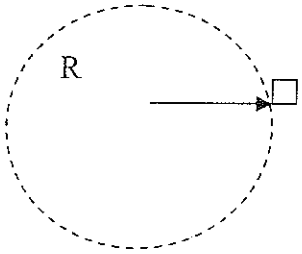
a) Find the tension in the string connecting the blocks
b) Find the acceleration of the blocks relative to the ground
c) Find the acceleration of the blocks relative to the lift (15)



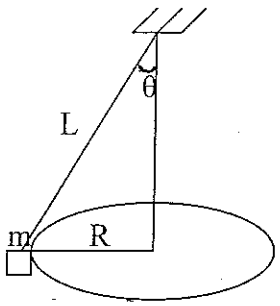
Q3. A 45° wedge is pushed along a table with constant acceleration A. A block of mass m slides without friction on the wedge. Find its acceleration. (Gravity is directed down) (12)



Q4. A small plastic box with a mass of 0.3 Kg revolves uniformly in a circle on a horizontal frictionless surface. The box is attached by a cord 0.14 m long to a pin set in the surface. If the box makes two complete revolutions per second, find the force F exerted on it by the cord. (12)



Q5. A 2kg mass swings in a horizontal circle at the end of a cord of length L=10m. What is the constant speed of the mass if the rope makes an angle of 30° with the vertical? Find the tension in the cord and the centripetal force. Draw the required free body diagram. (12)



Q6. a) An amusement park ride consists of a large vertical cylinder that spins about its axis fast enough that any person inside is held up against the wall when the platform is removed. The coefficient of friction between the wall and the person is 0.3 and the radius of the cylinder is 5.0 m. Find the maximum period of revolution necessary to prevent the person from falling. Limit your answer to the second position in the decimal system. (8)

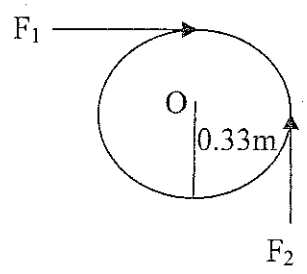
b) The force of attraction between the two spheres made of same material and radius when put in contact with each other is 98 N. If their radii are doubled and again put in contact with each other then find the new force between them. (4)

BITS, PILANI – DUBAI
International Academic City, Dubai
I-Year I-Semester 2010-11
Quiz- II (Closed Book)

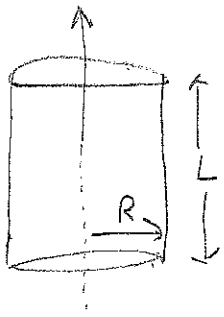
Course Name:	Physics I;	**Course No.:**	PHY C131;
Date:	06-12-10;	**Weightage:**	21%;
Duration.:	15minutes;	**Max Marks:**	21

Name :	**Id No:**	**Sec :**

1. Forces F_1 = 7.5 N and F_2 = 5.3N are applied tangentially to a wheel with radius, r = 0.33 m as shown. What is the net torque on the wheel due these two forces for an axis perpendicular to the wheel and passing through its centre?



2. A uniform solid cylinder has a radius R, Mass M and length L. Calculate its moment of inertia about its central axis.



3. The rim of a bicycle has a mass M and radius R and is rotating with an angular velocity ω. There are four beads of mass m each on the four spokes of the wheel halfway to the rim. The spokes are massless. Calculate the i) Moment of Inertia of the system about an axis passing through centre, perpendicular to the plane of the rim ii) Angular momentum of the system,

4. An oxygen molecule of moment of inertia 1.95×10^{-46} kg.m^2 is moving with an angular speed of 4.60×10^{12} rad/s , what is its rotational kinetic energy.

5. A disc of mass M and radius R is rolling, without slipping, on a smooth inclined plane of inclination 37^0 with the horizontal. The inclined plane has a length of 9 m. What will be its speed on reaching the bottom of the inclined plane? ($g = 10$ m/s^2)

BITS, PILANI – DUBAI
International Academic City, Dubai
I-Year I-Semester 2010-11
Quiz - I (Closed Book)

A

Course Name:	Physics I;	**Course No.:**	PHY C131;
Date:	25-10-10;	**Weightage:**	8%;
Duration.:	20 minutes;	**Max Marks:**	24

Name : **Id No:** **Sec :**

1. Sand falls from a stationary hopper onto a freight car which is moving with uniform velocity v. The sand falls at the rate dm/dt. How much force is needed to keep the freight car moving at the speed v. (5)

2. A non uniform thin rod of length L is placed along X- axis as such its one end is at the origin. The linear mass density of rod is $\lambda = \lambda_o x$. What is the center of mass of the rod from the origin. (λo = constant) (5)

3. A rocket consumes fuel at the rate of $100 kgs^{-1}$. The exhaust gases are ejected at a speed of $5x10^4 ms^{-1}$. What is the thrust experienced by the rocket. Neglect the effect of gravity. (5)

4. A rubber ball of mass 0.2kg falls to the floor. The ball hits with a speed of 8m/s and rebounds with approximately the same speed. The ball is in contact with the floor for 1ms. Find the force exerted on the ball by the floor. (5)

5. Two billiard balls each of mass 50g, moving in opposite direction each with a speed $6ms^{-1}$, collide and rebound with the same speed. Find the impulse imparted to each ball due to the other. (4)