# BITS, PILANI – DUBAI CAMPUS
# KNOWLEDGE VILLAGE, DUBAI

## I-Year I-Semester, 2004-05
## TEST-I

| | | | |
|---|---|---|---|
| **Course Name:** | Physics I; | **Course No.:** | PHY UC131; |
| **Date:** | 3rd Oct. 2004; | **Weightage:** | 20%; |
| **Max Marks:** | 20; | **Duration:** | 50 mins. |

*Note: Please start answering each new question on a fresh page.*

**Q I. A)** At a given time the force acting on a particle is F. At a later time the force is twice as large. What is the relation between the time rates of change of the momentum of the particle at the two times? **[½]**

**B)** In a baseball game, a 0.2 kg ball approaches a player (holding the bat) at a speed of 15 m/s at an angle of 45° below the horizontal. The player hits the ball in the opposite direction giving it a velocity of 40 m/s at 30° above the horizontal. **(a)** Determine the impulse delivered to the ball. **(b)** If the force on the ball is increasing linearly for 4.00 ms, holds constant for 20 ms and then decreases to zero linearly in another 4.0 ms, what is the maximum force on the ball? **(c)** Draw a Force – Time graph for this situation described in (b). **[2+1½ +1]**

**Q II.** Two small rigid disks, **A** and **B**, of equal mass, are involved in an elastic, glancing collision. The disk **B** is initially at rest and is struck by the disk **A** moving with a speed of 5.0 m/s. After the collision, the disk **A** moves along a direction that makes an angle of 37° with its initial direction of motion. The velocities of the two disks are perpendicular after collision, **(a)** Determine the final speeds of the two as seen by you. **(b)** Determine the velocity of the center of mass of the system. **(c)** Determine the two final velocities as seen by the center of mass. **[1 ½ +2 +1 ½ ]**

**Q III.** A rocket, set for vertical firing, weighs 50kg and contains 450 kg of fuel. It can have a maximum exhaust velocity of 2 km/s. **(a)** What should be its minimum rate of fuel consumption to give it an acceleration of 20 $m/s^2$. **(b)** What will be the maximum speed of the rocket when the rate of consumption of fuel is 10 kg/s. Gravity is present here as an external force. **[2+4]**

**Q IV.** A wheel runs with a constant angular speed of 312 rev/min. Due to friction, wheel comes to rest in 4.4 hrs. **(a)** After how many rotations will the wheel come to rest? **(b)** Consider a particle 52.4 cm from the axis of rotation, when the wheel is turning at 72.5 rev/min, what will be the magnitude of total linear acceleration of the particle in $m/s^2$? ($g = 9.8\ m/s^2$) **[2+2]**

# BITS, PILANI – DUBAI CAMPUS
# KNOWLEDGE VILLAGE, DUBAI

## I-Year I-Semester 2004-05
## TEST I (Closed Book) Make-up

| | | | |
|---|---|---|---|
| **Course Name:** | Physics I; | **Course No.:** | PHY UC132; |
| **Date:** | 12th Oct. 2004; | **Weightage:** | 20%; |
| **Test No.:** | TEST 1; | **Max Marks:** | 20 |

Q I. In a particular crash test, a car of mass 1500 kg collides with a wall. The initial and final velocities of the car are $v_i = -15\hat{i}$ m/s and $v_f = (2.6\hat{i})$ m/s + $(1.5\hat{j})$ m/s, respectively. If the collision lasts for 0.15 s, a) find the impulse ($\vec{J}$) caused by the collision and the average force exerted on the car.

b) If the car did not rebound, what would be the $\vec{J}$?

c) Out of these two conditions, which would you prefer as the driver? Why? [2 + 1½ + 1½]

Q II Two automobiles of equal mass approach an intersection. One vehicle is traveling with speed 13.0 m/s toward the east, and the other is traveling north with speed $v_{2i}$. Neither driver sees the other. The vehicles collide in the intersection and stick together, leaving

both roads is 35 mi/h, and the driver of the northward-moving vehicle claims he was within the speed limit when the collision occurred. a) Is he telling the truth? b) What is the motion of CM before & after the collision? c) Final vel. in CM frame? [2+2+1]

QIII
a) If the centre of mass of three particles of masses 1, 2 and 3 kg be at the point (3,3,3) where should be a fourth mass of 4 kg be placed so that the centre of mass of the four particles be at the point (1, 1, 1).

b) Find the centre of mass of a homogeneous semicircular plate of radius R and mass M.

[3+3]

QIV A rigid object rotating about the z-axis is slowing down at 2.66 rad/s². Consider a particle located at $\vec{r} = (1.83\,m)\hat{j} + (1.26\,m)\hat{k}$. At the instant that $\vec{\omega} = (14.3\ rad/s)\,\hat{k}$, find a) the velocity of the particle and (b) its acceleration

[2+2]

# BITS, PILANI – DUBAI CAMPUS
# KNOWLEDGE VILLAGE, DUBAI

## I-Year I-Semester
## TEST II (Open Book)

| | | | |
|---|---|---|---|
| **Course Name:** | Physics I; | **Course No.:** | PHY UC131; |
| **Date:** | 28th Nov 2004; | **Weightage:** | 20%; |
| **Test No.:** | TEST II; | **Max Marks:** | 20 |

**Note: Only one Book is allowed. Written or zeroxed material should be allowed.**

**Q 1.** A solid sphere of mass m rolls without slipping on an inclined plane of inclination θ. **(a)** Find the linear acceleration of the sphere and the force of friction acting on it. **(b)** What should be the minimum coefficient of static friction to support pure rolling? **[3]**

**Q 2.** Derive the expression for moment of inertia of a solid cylinder of mass M and radius R about the axis through its center and perpendicular to its axis of cylindrical symmetry along the length. **[4]**

**Q 3.** A wheel is rotating with an angular speed of 500 rev/min on a shaft whose rotational inertia is negligible. A second identical wheel, initially at rest, is suddenly coupled to the same shaft. What is the angular speed of the resultant combination of the shaft and the two wheels? **[3]**

**Q 4.** A box is being moved with a velocity **v** by a force **P** (parallel to **v**) along a level horizontal floor. The normal force is $\mathbf{F_N}$, the kinetic frictional force is $\mathbf{f_k}$, and the weight of the box is **mg**. Decide which forces do positive, zero, or negative work. Provide a one-line reason for each. **[3]**

**Q 5.** A small block of mass m slides along the frictionless loop shown in Fig. below. Find the minimum height h above the bottom of the track from where you must release the block so that it will not leave the track at the top of the loop. Take $g = 10\ m/s^2$. **[3]**

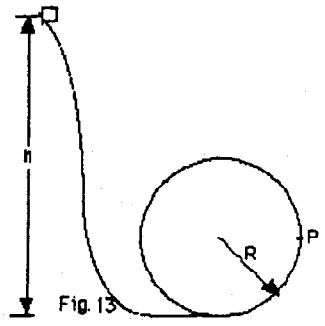


Fig. 13

**Q 6.** A ball of mass m = 1.0 kg is attached to a spring and the spring is attached to a fixed point P, as shown in Fig. below. The spring cannot bend. The ball is moving in a circle of radius R in a horizontal plane with a velocity v. The spring is massless and the plane on which the ball moves is frictionless. **(a)** If R = 1.0 m and v = 1.0 m/s, what is the tension in the spring at the point where it attaches to m? **(b)** If the ball and spring now rotate with v = 2.0 m/s, what is the new radius of the ball's path. **(c)** How much work is done on the mass and on the spring. **(d)** If the relaxed length of the spring is 0.90 m, what is the spring constant k? **[4]**

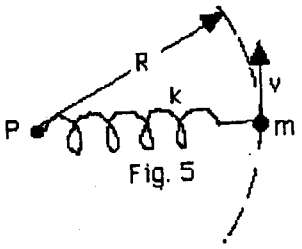


Fig. 5

# BITS, PILANI – DUBAI CAMPUS
# KNOWLEDGE VILLAGE, DUBAI

## I-Year I-Semester
## TEST II (Open Book)
## Make-Up

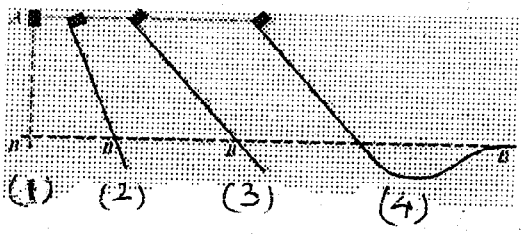
| | | | |
|---|---|---|---|
| **Course Name:** | Physics I; | **Course No.:** | PHY UC131; |
| **Date:** | 8th Dec 2004; | **Weightage:** | 20%; |
| **Test No.:** | TEST II; | **Max Marks:** | 20 |

**Note: Only one Book is allowed. Written or zeroxed material should not be allowed.**

**Q 1.** Derive an expression for the rotational inertia of a uniform solid sphere of mass M and radius R about an axis through its center. **[5]**

**Q 2.** A uniform ladder of mass 10 kgs leans against a smooth vertical wall making an angle of 53° with it. The other end rests on a rough horizontal floor. Find the normal force and the frictional force that the floor exerts on the ladder. **[5]**

**Q 3.** The figure shows four situations: one in which an initially stationary block is dropped and three in which the block is allowed to slide down frictionless ramps. Which situation will the block have the greatest kinetic enegy at B? **[1]**




**Q 4.** A body of mass M, initially at rest, explodes into three parts. One part of mass ¼ M travels along east with a velocity 6 m/s. The second part of mass ¼ M travels south with a speed of 7.5 m/s. (a) What is the momentum of the third part. (b) How much kinetic energy appears in the explosion process? **[4]**

**Q 5.** A 15 kg object and a 10 kg object are suspended, joined by a cord that passes over a pulley with a radius of 10 cm and a mass of 3 kg. The chord has a negligible mass and does not slip on the pulley. The pulley rotates on its axis without friction. The objects start from rest 3 m apart. Treat the pulley as a uniform disk, and determine the speeds of the two objects as they pass each other. **[5]**

P.T.O

# BITS, Pilani-Dubai Campus
# Knowledge Village
# Dubai

## I-Year I-Semester 2004
## QUIZ (CB), Make-Up

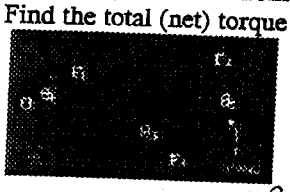
**Course:** Physics I; **Course No.:** PHY UC131;
**Max. Marks:** 10 **Duration:** 30 mins

*Candidate's Name:* _____

*I.D. No.:* _____ *Section:* _____

**NOTE: Keep your explanations to a maximum of one line.**

**Q 1.** Figure 1 shows an object with several forces acting on it. The pivot point is at O.
$F_1$ = 10 N, and is at a distance of 0.25 m from O, where $\theta$ = 80°
$F_2$ = 7.0 N, acting perpendicular to the object, at a distance of 1.25 m from O
$F_3$ = 12 N, is 0.60 m from O, and acts at $\theta$ = 40° from the horizontal
Find the total (net) torque on the object.



**Ans:** $\tau_{net} = 6.58\ Nm$

**Q 2.** A ball rolls without slipping down incline A, starting from rest. At the same time, a box starts from rest and slides down incline B, which is identical to incline A except that it is frictionless. Which arrives at the bottom first?
(a) the ball (b) the box (c) both arrive at the same time (d) impossible to determine.

**Q 3.** The moment of inertia depends on the choice of axis. Which axis for a body would have the smallest moment of inertia?
(a) axis passing through the corner of the body, (b) axis passing through the geometric center of the body, (c) axis passing through the center of mass of the body.

**Q 4.** A diver leaves diving board and falls towards the water with her body straight and rotating slowly. She pulls her arms and legs into a tight tuck position. Her angular speed would increase.

**Q 5.** Spring A is stiffer than spring B; i.e., $k_A > k_B$. The spring force of which spring does more work if the springs are compressed the same distance.

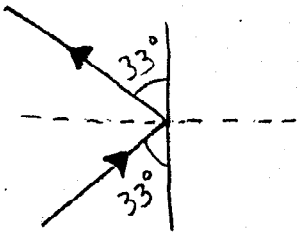
**Ans:** 'A' does more work than 'B'

# BITS PILANI- DUBAI CAMPUS
# KNOWLEDGE VILLAGE , DUBAI
# I-YEAR, I SEM, 2004-05
# COMPREHENSIVE EXAMINATION

COURSE TITLE: PHYSICS-I
DATE: 5.1.2005
MAX MARK : 80

COURSE NO: PHY UC 131
WEIGHTAGE: 40%
DURATION : 3 HRS

**Q 1.** A 325 g ball with a speed of 6.22 m/s strikes a wall at an angle of 33 degree and then rebounds with the same speed and angle. It is in contact with the wall for 10.4 ms.

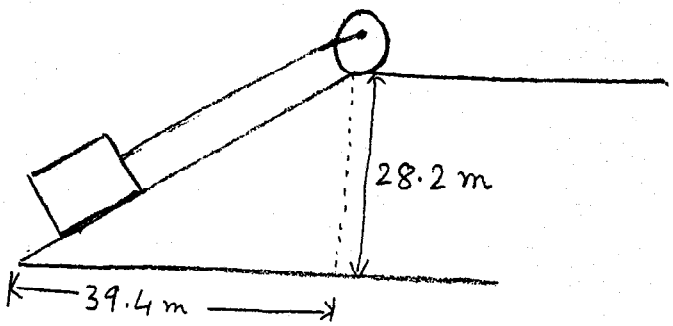



(a) What impulse was experienced by the wall?
(b) What was the average force exerted by the ball on the wall? **(4+4)**

**Q 2.** A projectile of mass 9.6 kg is launched from the ground with initial velocity of 12.4 m/s at an angle of 54 degree above the horizontal. At some time after its launch, an explosion splits projectile into two pieces. One piece, of mass 6.5 kg, is observed at 14.2 s after the launch at a height of 5.9 m and a horizontal distance of 13.6 m from the launch point. Find the location of the second fragment at that same time. **(8)**

**Q 3.** A pulley, which can be considered as a uniform disc of mass 2.5 kg and radius 20cm, mounted on a fixed (frictionless) horizontal axle. A block of mass 1.2 kg hangs from a light cord that is wrapped around the rim of the disc. Find the acceleration of the falling block, the tension in the card, and the angular acceleration of the disk. **(8)**

**Q 4.** A 1380 kg block of granite is dragged up an incline at a constant speed of 1.34 m/s by a steam winch (lifting device). The coefficient of kinetic friction between the block and the incline is 0.41. How much power must be supplied by the winch. **(8)**




Note: Pl. write answers of all parts of a ques. in sequence.



$m_e = 9.1 \times 10^{-31}$ kg, $e = 1.602 \times 10^{-19}$ C, $h = 6.6 \times 10^{-34}$ J.s
$g = 9.8$ m/s$^2$

**Q 5.** **A)** A particle moves along x- axis under the influence of a conservative force that is described by $\vec{F} = -\alpha x \varepsilon^{-\beta x^2} \hat{\imath}$ where α and β are constants. Find the potential energy function U(x). **(4)**

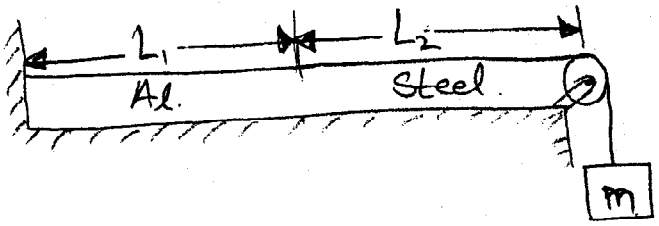
**B)** Give the statement of perpendicular axis theorem with complete derivation? **(4)**

**Q 6.** **A)** In a Block-Spring-Earth system if Earth is taken as an external agent, write a Work-Energy equation and explain it. **(3)**

**B)** A skater of mass 120 kg skates towards a railing and grasps it with his outstretched arms. Before coming to rest his center-of-mass moves a distance 35 cm towards the rails and the average force he exerts on the rails is 1820 N. **(a)** Find the velocity with which he was initially moving. **(b)** How much internal energy does he lose during this process? **(5)**

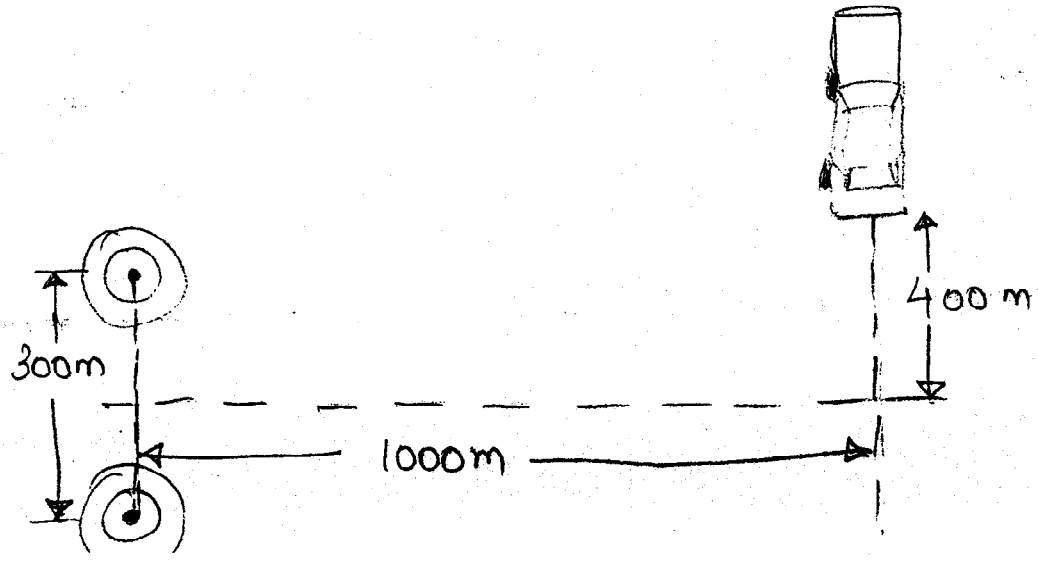
**Q 7.** **A)** **(a)** A crazy ball is dropped from a height. It bounces back to the same height repeatedly. Is the motion a simple harmonic motion? Explain **(b)** Is it possible to have damped oscillations when a system is at resonance? Explain. **(4)**

**B)** An aluminium wire of length $L_1$ = 60 cm and of cross-sectional area $1.00 \times 10^{-2}$ $cm^2$ is connected to a steel wire of the same cross-sectional area. The compound wire, loaded with a block m of mass 10.0 kg, is arranged as shown in the Figure below so that the distance $L_2$ from the joint to the supporting pulley is 90 cm. Transverse waves are set up in the wire. **(a)** Find the lowest frequency of excitation for which standing waves are observed such that the joint in the wire is a node. **(b)** What is the total number of nodes observed at this frequency? The density of aluminium is 2.60 $g/cm^3$ and that of steel is 7.80 $g/cm^3$. **(4)**




**Q 8.** **A)** What is the necessary condition on the path length difference between two waves that interfere **(a)** constructively and **(b)** destructively? How can you findout phase difference from path difference? **(3)**

**B)** Two radio antennas separated by 300 m as shown in the figure simultaneously broadcast identical signals at the same wavelength A radio in a car traveling due north receives the signals. **(a)** If the car is at the position of the second maximum, what is the wavelength of the signals? **(b)** How much farther must the car travel to encounter the next minimum in reception? **(5)**



**Q 9. A)** In a double-slit diffraction pattern, the third principal maximum is missing because that interference maximum coincides with the first diffraction minimum. **(a)** Find the slit width and the separation between the slits. How would the pattern change if, **(b)** the slit width is doubled, **(c)** the slit separation is doubled. **(4)**

**B)** A source emits 531.62 nm and 531.81 nm light. **(a)** What minimum number of grooves is required for a grating that resolves the two wavelengths in the first-order spectrum? **(b)** Determine the slit spacing for a grating 1.32 cm wide that has the required minimum number of grooves. **(4)**

**Q 10. A)** In the photoelectric effect, **(a)** explain why the stopping potential depends on the frequency of light but not on the intensity. **(b)** Why does the existence of a cutoff frequency favor a photon theory of light over a wave theory? **(4)**

**B)** X-rays of wavelength $\lambda_o = 0.2000$ nm are scattered from by a light material. The scattered x-rays are observed at an angle of 45.0° to the incident beam. Calculate their wavelength. **(4)**