

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

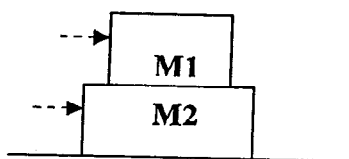
I-Year I-Semester 2006-07

Test-1 (Closed Book)

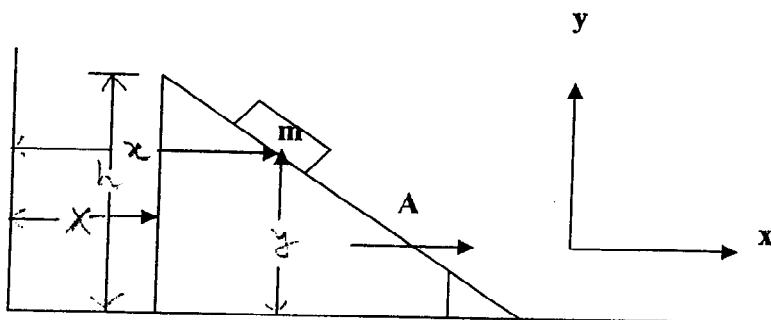
Course Name:	<u>Physics I;</u>	Course No.:	<u>PHY UC131;</u>
Date:	<u>15<sup>th</sup> Oct. 2006;</u>	Weightage:	<u>20%;</u>
Test No.:	<u>Test 1;</u>	Max Marks:	<u>60 marks</u>

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1. A block of mass  $M_1$  rests on a block of mass  $M_2$  which lies on a frictionless table. The coefficient of friction between the block is  $\mu$ . What is the maximum horizontal force which can be applied to the blocks for them to accelerate without slipping on one another if the force  $F$  is applied to (a) block 1 and (b) block 2?  
(5+5=10 marks)

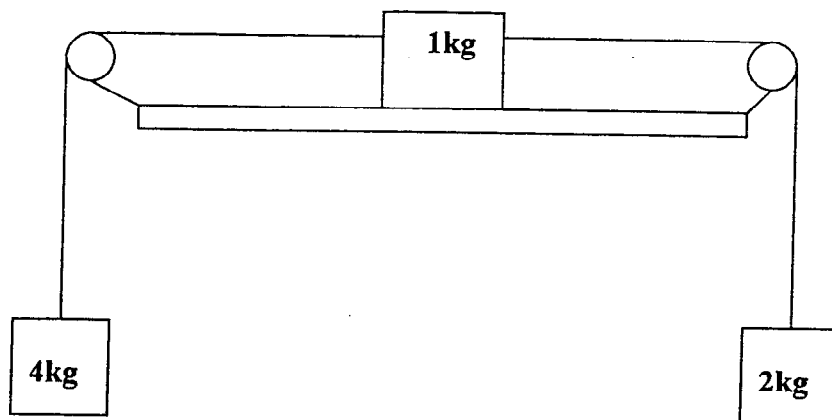


2. A  $45^\circ$  wedge is pushed along a table with constant acceleration  $A$ . A block of mass  $m$  slides without friction on the wedge. Position coordinates of mass  $m$  is  $(x,y)$ . Find the acceleration of the block. (Gravity is directed down).  
(10 marks)



3. Three objects are connected on the table as shown in figure. The table is rough and has a coefficient of kinetic friction of  $0.350$ . The objects have masses of  $4.00\text{kg}$ ,  $1.00\text{kg}$  and  $2.00\text{kg}$  as shown and the pulleys are frictionless. Draw the Force Diagram of each of the objects and calculate their acceleration.

( 10 marks)



4. A rocket moving in free space has a speed of  $3 \times 10^3 \text{ m/s}$  relative to the earth. Its engines are turned on and fuel is ejected in a direction opposite the rockets motion at a speed of  $5 \times 10^3 \text{ m/s}$  relative to the rocket.
- What is the speed of the rocket relative to the earth once the rocket's mass is reduced to half its original mass.
  - What is the acceleration of the rocket if the fuel burns at the rate of  $50\text{kg/s}$  and the mass at that instance =  $2 \times 10^3 \text{ kg}$ . (5+5=10 marks)
5. A ball of mass  $140\text{g}$  and speed  $7.8\text{m/s}$  strikes a wall perpendicularly and rebounds with the same speed. If the time of collision is  $3.9\text{ms}$ , what is the impulse experienced by the wall and the average force exerted by the wall.

(10 marks)



6. A thin strip of material of mass  $M$  is bent into the shape of a semicircle of radius  $R$ . Find its center of mass.

(10 marks)

BITS, Pilani- Dubai Campus  
 Knowledge Village  
 I Year I Semester 2006-07  
Comprehensive Exam

Course Name: PHYSICS I  
 Date: 25<sup>th</sup> Dec '06  
 Duration: 3 hrs

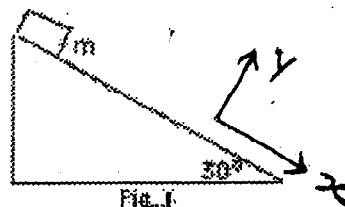
Course No.: PHY UC131  
 Weightage: 40%  
 Max. Marks: 120

Answer Section A, B and C in separate answer sheets , Answer all the questions sequentially, Start every new question on a fresh page, All questions are compulsory, Data provided is sufficient

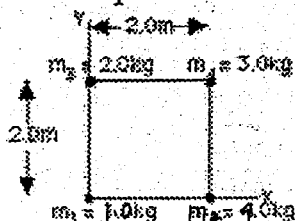
SECTION A

Q1. An object of mass  $m = 3.0$  kg accelerates down the frictionless inclined plane of Fig. 1 below. (a) Draw and calculate the components of the forces on the X and Y-axes. (b) Find the acceleration of the block. (c) Find and draw the components of forces on the X and Y axes if there exists a coefficient of friction  $\mu_k$  between the surface and the object of 0.154. (d) Find the acceleration of the block for this situation. Take  $g = 10$  m/s<sup>2</sup>.

[2½+2½+2½+2½]



Q2. A) Four particles are distributed in the X-Y plane as shown in figure below. Find the coordinates ( $X_{CM}$ ,  $Y_{CM}$ ) of the particles. The particles are on the corners of a 2.0-m square. [5]

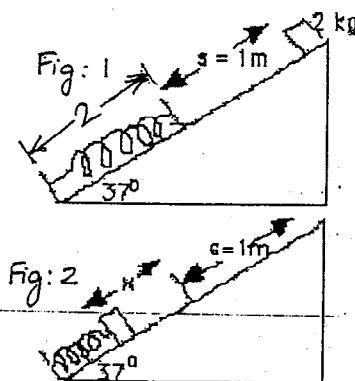


B) A 1500-kg automobile travels eastward at a speed of 8.0 m/s. It makes a 90° turn to the north in a time of 3.0 s and continues with the same speed. Find (a) the impulse delivered to the car as a result of the turn (b) the average force exerted on the car during the turn. [2½+2½]

Q3. A block of mass  $m = 2$  kg is held at the top of an incline plane that makes an angle of 37° with the horizontal. The initial position of the block is shown in Fig. 1 below where it is a distance  $s = 1.0$  m from a spring with constant  $k = 120$  N/m. The Fig. 2 below, shows the final position of the block. (a) What is the potential energy of the block? The coefficient of friction between the surface and the block is 1/8. As the block makes contact with the spring, it continues to move until it compresses the spring to a maximum distance  $x$ . For the "final position", find (b) the final kinetic energy of the block just before it hits the spring, (c) the work done by the frictional force. (d) the

final potential energy of the block [Take  $g = 10 \text{ m/s}^2$ ].

[5+5+5+5]



### SECTION B

Q4. A wooden block of mass  $0.9 \text{ kg}$  is suspended from the ceiling of a room by thin wires. A bullet of mass  $0.1 \text{ kg}$  moving horizontally with a speed of  $100 \text{ m/s}$  strikes the block and sticks to it. What is the height to which the block rises? ( $g = 10 \text{ m/s}^2$ ). [10]

Q5. A solid cylinder of mass  $M$  and radius  $R$  rolls down an inclined plane of height  $h$ .  
 a) What is the angular velocity of the cylinder when it reaches the bottom of the plane?  
 b) What is the rotational kinetic energy of the cylinder when it reaches the bottom?

[5+5]

Q6. A particle of mass  $m$ , attached with a spring of force constant  $k$  oscillates with an amplitude of  $A$  whose simple harmonic motion is described by the equation

$$x = A \cos(\omega_0 t + \Phi)$$

a) Calculate the average kinetic energy and average potential energy  
 b) If the particle experiences a resistive force of magnitude  $bv$  where  $b$  is a constant and  $v$  is the velocity, what will be the new equation of motion and the new angular frequency?

[6 + 4]

Q7. Derive an expression for the moment of inertia of a uniform disc of mass  $M$  and radius  $R$  about an axis through the centre and perpendicular to the plane of the disc?

[10]

### SECTION C

Q8. The phase velocity  $v$  of a transverse wave in a crystal of atomic separation  $a$  is given by  $v = c \left\{ \frac{\sin(ka/2)}{(ka/2)} \right\}$ , where  $k$  is the wave number and  $c$  is constant. Show that the value of the group velocity is  $c \cos ka/2$ .

[10]

Q9. The equation of a transverse wave traveling along a very long string is given by

$$y = 6.0 \text{ cm} \sin \{ (2\pi \text{ rad/m}) x + (4\pi \text{ rad/s}) t \}$$

Calculate a) the amplitude, b) the wavelength c) frequency d) speed [10]

Q10. A soap film ( $n = 1.33$ ) in air is  $320 \text{ nm}$  thick. If it is illuminated with white light at normal incidence, what wavelength will it appear in reflected light for the second order? [10]

Q11. A diffraction grating has  $10^4$  rulings uniformly spaced over  $25 \text{ mm}$ . It is illuminated at normal incidence by a light of wavelength  $589 \text{ nm}$ . At what angle will the first order maximum occur for this wavelength? [10]

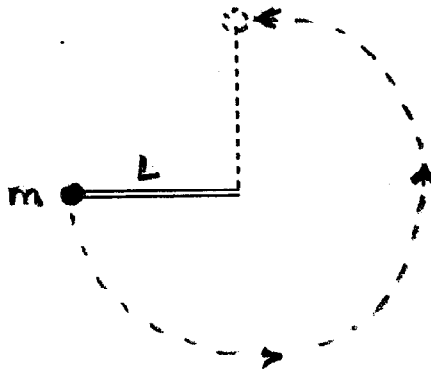
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I-Year I-Semester 2006-07  
Test- II Make-up (Open Book)

Course Name:	<u>Physics I;</u>	Course No.:	<u>PHY UC131;</u>
Date:	<u>14-12- 2006;</u>	Weightage:	<u>20%;</u>
Time:	<u>50 min</u>	Max Marks:	<u>60 marks</u>

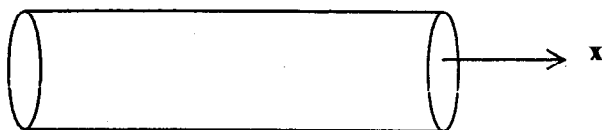
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1. A ball of mass  $m$  is attached to the end of a very light rod of length  $L$ . The other end of the rod is pivoted so that the ball can move in a vertical circle. The rod is pulled aside to the horizontal and given a downward push as shown in figure so that the rod swings down and just reaches the vertically upward position. What initial speed was imparted to the ball? **10marks**



2. In a game of pool, the cue ball strikes another ball initially at rest. After the collision, the cue ball moves at  $3.50\text{m/s}$  along a line making an angle of  $65^\circ$  with its original direction of motion. The second ball acquires a speed of  $6.75\text{m/s}$ . Using momentum conservation, find a) the angle between the direction of motion of the second ball and the original direction of the cue ball and b) the original speed of the cue ball? **10 marks**
3. A wheel with rotational inertia  $1.27\text{ kg}\cdot\text{m}^2$  is rotating with an angular speed of  $824\text{ rev/min}$  on a shaft whose rotational inertia is negligible. A second wheel, initially at rest and with rotational inertia  $4.85\text{kg}\cdot\text{m}^2$ , is suddenly coupled to the same shaft. What is angular speed of the resultant combination of the shaft and two wheels? **10 marks**

4. Calculate the rotational inertia of a solid cylinder of mass  $M$ , length  $L$  and radius  $R$  about the  $X$  axis of rotation?  
10 marks



5. A mass on the end of a spring oscillates with an amplitude of 5cm at a frequency of 1Hz (cycles per second). At  $t = 0$  the mass is at its equilibrium position  $x = 0$ .
- Find the possible equations describing the position of the mass as a function of time, in the form  $x = A \cos(\omega t + \alpha)$ . What are the numerical values of  $A$ ,  $\omega$  and  $\alpha$ .
  - What are the values of  $x$ ,  $dx/dt$ ,  $dx^2/dt^2$  at  $t = 3/8$  sec,  $K$  and  $U$  [4+6]
6. An object of mass 0.2kg is hung from a spring whose spring constant is 80N/m. The object is subject to a resistive force given by  $-bv$ , where  $v$  is the velocity in m/s.
- Set up the differential equation of motion for free oscillations of the system.
  - If the damped frequency is 0.995 of the undamped frequency, what is the value of constant  $b$ ?
  - What is the  $Q$  of the system and by what factor is the amplitude of the oscillation reduced after 4 complete cycles? [3+3+4]

NAME:

I.D.:

Sec No:

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I-Year I-Semester 2006-07  
QUIZ-II Make-up (Closed Book)

Course Name:	Physics I;	Course No.:	PHY UC131;
Date:	30 <sup>th</sup> Nov. 2006;	Weightage:	10%;
Time.:	30 min	Max Marks:	30 marks

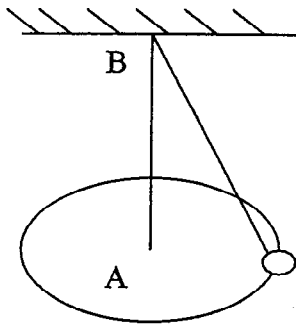
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**NOTE:** *Answer* all questions. Use the attached blank sheet for rough work.

1. A box is dragged along a horizontal floor by a rope which makes an angle of  $55^\circ$  with the horizontal. How much work is done if the tension of the rope is 140 N and the box is dragged through a distance of 8m. [3]
  
2. A horizontal force  $F$  pulls a 25kg box along a horizontal floor. If the coefficient of friction between the box and the floor is 0.30 how much work is done by the force  $F$  in moving the box through a distance of 3m. (Take  $g = 9.8 \text{ ms}^{-2}$ ) [3]

3. A particle of mass  $m$  is moving in a horizontal circle of radius  $r$  under a centripetal force  $F = k/r^2$  where  $k$  is a constant. What is the total energy of the particle. [3]

4. For the conical pendulum shown below what is the magnitude and direction of  $L$  and torque about points A and B [3]

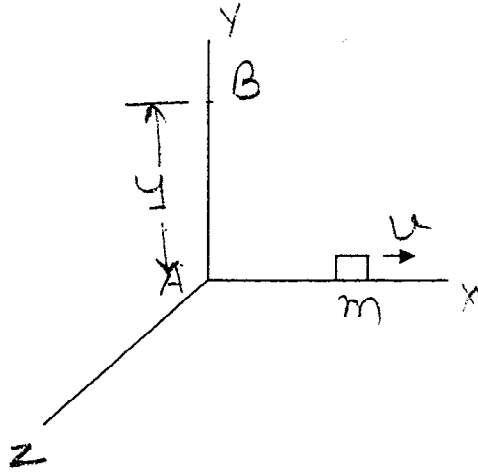




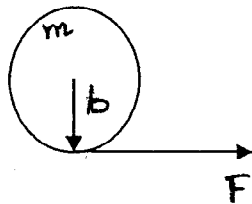
5. Joule is a unit of
- a) work
  - b) power
  - c) impulse
  - d) energy
  - e) work and energy
- [2]
6. A marble is launched from a spring gun with a speed  $v$  by pushing the spring a distance  $d$ . For the next loading the spring is pushed a distance  $2d$ . How much faster does the second marble leave the gun compared to the first?
- a) 4 times
  - b) 2 times as fast
  - c) same
  - d) half time
- [2]
7. An older model car accelerates from rest to speed  $v$  in 10 sec. A newer more powerful sports car accelerates from rest to  $2v$  in the same time period. What is the ratio of the power of the newer car to that of the older car?
- a) 0.25
  - b) 2
  - c) 0.5
  - d) 4
- [2]
8. A rocket works on the principle of conservation of
- a) mass
  - b) energy
  - c) linear momentum
  - d) angular momentum
- [2]
9. A moving bullet hits a solid target resting on a frictionless surface and gets embedded in it. What is conserved in this process
- a) momentum and kinetic energy
  - b) kinetic energy alone
  - c) momentum alone
  - d) neither momentum nor kinetic energy
- [2]
10. The moment of inertia of a uniform thin hoop of mass  $M$  and radius  $R$  whose axis passing through the center and perpendicular to the plane of the hoop is -  
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- [2]

11. A block is sliding with an initial velocity  $v$  on a rough surface. In the figure below represent the angular momentum  $L$  and the torque about the points A and B. Write the value for the same?

[3]



12. A disc of mass  $M$  and radius  $b$  is pulled with constant force  $F$  by a tape wound around its circumference. The disk slides on ice without friction. What is its angular motion?



[3]



3. A rod of mass  $M$  and length  $L$  is pivoted at one end and lies flat on a frictionless table. It is moving with angular velocity  $\omega$ . A chewing gum of mass  $m$  falls and sticks to the free end of the rod. What is the velocity of the chewing gum. [3]

4. A particle moves along the  $x$  axis from  $x = 0$  to  $x = 5\text{m}$  under the influence of a force given by  $F = 7 - 2x + 3x^2$ . What is the work done in the process? [3]

5. After being hit, a golf ball starts out with a velocity of 130ft/s. If it reaches a maximum height of 180ft, what is its velocity at that point? (Take  $g = 32\text{ft/s}^2$ ) [3]

6. Find the angular momentum of the earth associated with its rotation on its axis? ( Given Mass of earth=  $5.98 \times 10^{24}$  kg and Radius of earth  $6.37 \times 10^6\text{m}$ ) [3]

7. Calculate the rotational inertia of a meter stick with mass 0.56kg about an axis perpendicular to the stick and located at the 20cm mark. [2]

8. In an isolated system, which of the following is a correct statement of the quantity that is conserved?  
1. Kinetic energy  
2. Potential energy  
3. Sum of Kinetic and potential energy  
4. Both kinetic energy and potential energy [2]

9. What does the slope of a graph of  $U(x)$  versus  $x$  represent?
1. The force on the object
  2. The negative of the force on the object
  3. The negative of the  $x$ -component of the force on the object
  4. The  $x$  component of the force on the object

[2]

10. In an elastic collision between two particles, what is conserved?
1. Kinetic energy of each particle
  2. Sum of kinetic energy and sum of momenta of the two particles
  3. Kinetic energy and momentum of each particle
  4. Momentum of each particle

[2]

11. A bomb, initially at rest, explodes into several pieces
1. Is the linear momentum of the system conserved?
  2. Is the kinetic energy of the system conserved?

[2]

12. A solid sphere and a hollow sphere have same radii and mass. They are rotating with the same angular speed.
- a) solid sphere has higher angular momentum
  - b) hollow sphere has higher angular momentum
  - c) both have same angular momentum
  - d) impossible to determine which has higher angular momentum

[2]

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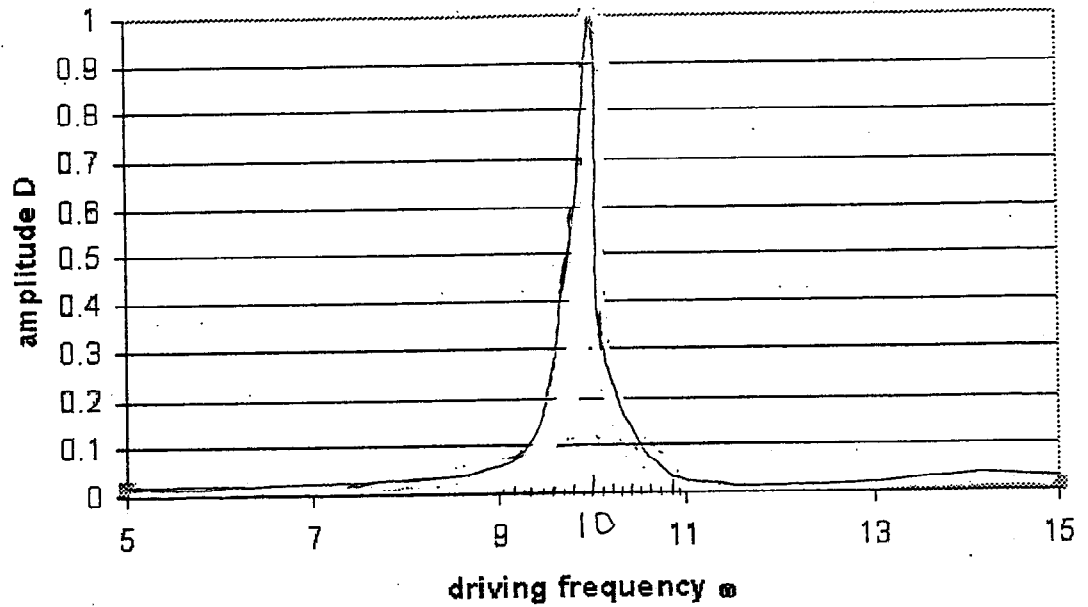
I-Year I-Semester 2006-07  
Test- II (Open Book)

Course Name:	<u>Physics I;</u>	Course No.:	<u>PHY UC131;</u>
Date:	<u>4-12- 2006;</u>	Weightage:	<u>20%;</u>
Time:	<u>50 min</u>	Max Marks:	<u>60 marks</u>

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1. A particle moves along the X axis under the influence of a conservative force that is described by  
$$F = -\alpha x e^{-\beta x^2}$$
where  $\alpha$  and  $\beta$  are constants. Find the potential energy function  $U(x)$  assuming potential is zero at infinity **10 marks**
2. A particle moving with 9m/s collides with another identical particle at rest. After the collision both the particles make an angle of  $30^\circ$  with the initial direction. Find the velocities of both the particles after the collision? **10 marks**
3. In an Atwood's machine one block has a mass of 550g and the other a mass of 475g. The massive pulley which is mounted in horizontal frictionless bearings has a radius of 5.25cm. When released from rest, the heavier block is observed to fall 78cm in 5.15s. Calculate the rotational inertia of the pulley. ( $g=9.8\text{m/s}^2$ ) **10 marks**
4. A thin spherical shell has a radius of 1.88m. An applied torque of 960 N.m imparts an angular acceleration equal to  $6.23\text{ rad/s}^2$  about an axis through the center of the shell.  
(a) Calculate the rotational inertia of the shell about the axis of rotation  
(b) the mass of the shell **[5+5]**
5. A block of mass 2 kgs is attached to a horizontal spring of force constant 6 N/cm. The spring is compressed by 22 cm and then released  
a. What is the amplitude of displacement and velocity?  
b. What is the Kinetic and potential energy at 16 cm from the equilibrium point?  
c. How far is the spring compressed when the block has a velocity of 3 m/s? **[2+4+4]**

6. An oscillator with mass  $m = 0.80$  kgs,  $k = 1.4$  kN/mm and  $b = 64$  kg/s, is driven by a sinusoidal force with frequency  $1.6$  kHz and amplitude  $3.0$  kN.
- What is the amplitude and phase of steady state oscillation?
  - If the force applied is removed the amplitude falls to half its value in  $0.017$  secs. Calculate the number of oscillations required to bring about this change in amplitude.
  - Calculate the  $Q$  factor from the graph shown below.



[3+4+3]





3. A rod of mass  $M$  and length  $L$  is pivoted at one end and lies flat on a frictionless table. It is moving with angular velocity  $\omega$ . A chewing gum of mass  $m$  falls and sticks to the free end of the rod. What is the linear velocity of the chewing gum. [3]

4. A particle moves along the  $x$  axis from  $x = 0$  to  $x = 5\text{m}$  under the influence of a force given by  $F = 7 - 2x + 3x^2$ . What is the work done in the process? [3]

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  2. Sum of kinetic energy and sum of momenta of the two particles
  3. Kinetic energy and momentum of each particle
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11. A bomb, initially at rest, explodes into several pieces

1. Is the linear momentum of the system conserved?
2. Is the kinetic energy of the system conserved?
3. What type of collision occurs here?

[2]

12. A solid sphere and a hollow sphere have same radii and mass. They are rotating with the same angular speed.

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- b) hollow sphere has higher angular momentum
- c) both have same angular momentum
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[2]