CHUKA UNIVERSITY

COLLEGE

UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE (GENERAL), BACHELOR OF SCIENCE (COMPUTER SCIENCE) AND BACHELOR OF EDUCATION (ARTS)

PHYS 112: MECHANICS

STREAM: B.SC. (GEN.), B.SC (COMP.SCI) & B.ED (ARTS) Y1S1 **TIME: 2 HOURS**

DAY/DATE: THURSDAY 9/12/2010 **11.30 A.M. – 1.30 P.M**

INSTRUCTIONS:

- Question ONE is compulsory and carries 40 marks.
- Other questions carry 15 marks.
- Answer question one and any other TWO.

Q.1 (a) Given below are some statements. Decide whether they are true or false giving reasons for your choice.

(i) A car covers the first half of its distance between two places at a speed of 40 km/hr and the second half at 60 km/hr. The average speed of the car is then 50 km/hr. [2 marks]

(ii) It is possible to sometimes have a single isolated force. [2 marks]

(iii) The total energy of a body in motion is equal to the work it can do in being brought to rest. [2 marks]

(iv) The outside "horses" on a merry go round get more acceleration than the inside ones. [2 marks]

(iv) A quick collision between two bodies is more violent than a slow collision even when the initial and the final velocities are identical. [2 marks]

(b) Three vectors are given as follows:

$\overline{A} = i - 3j$

$\overline{B} = 2i + 4j$

$\overline{C} = 2i + j - 4j$

(i) Show that $\overline{A} \times \overline{B} = - \overline{B} \times \overline{A}$ [3 marks]

(ii) Find $\overline{A} . (\overline{B} \times \overline{C})$ [3 marks]

(c) (i) State the work-energy principle. [1½ marks]

(ii) A coin of mass 3.2g is dropped vertically to a floor a distance of 11m. Determine the speed of the coin just before it hits the floor. [3 marks]

(d) (i) Distinguish between elastic and inelastic collision. [1½ marks]

(ii) A particle of mass = 70g is initially at rest. Another particle of mass M_2 = 35g moving with a velocity of $1.9ms^{-1}$ collides with M_2 elastically. What are the velocities of the two particles after the collision? [4 marks]

(e) From the top of a tower of height 50m, a ball is thrown vertically upward with a certain velocity. It hits the ground 10s after it is thrown up. With what velocity is that ball projected? [4 marks]

(f) A car of mass 1200Kg falls vertically a distance of 24m starting from rest. What is the work done by the force of gravity on the car? Use the work-energy theorem to find the final velocity of the car just before it hits the ground. (Treat the car as pointlike). [6 marks]

(6) A train has to negotiate a curve of radius 300m. By how much will the outer rails be raised with respect to the inner rail for a speed of 54km $h^{-1?}$ The distance between the rail is 1.5m. (Take g = $10ms^{-1}$). [4 marks]

Q.2 (a) Two forces are given by $\overline{F}_1 = 2j + 3k$ and $\overline{F_2} = -4j - 5j$. Calculate the resultant force and the angle between the forces. [4 marks]

(b) A particle has shifted along some trajectory in the plane xy from point 1 whose radius vector $\overline{r_1} = i + 2j$ to point 2 with the radius vector $\overline{r_2} = 2i - 3j$. During that time the practice experienced the action of certain forces, one of which $\overline{F} = 3i + 4j$. Find the work performed by the force $\overline{F}$.
(Here $\overline{r_1}$, $\overline{r_2}$ and $\overline{F}$ are given in SI units) [3 marks]

(c) A string of length 1m is fixed at one end and carries a mass of 100g at the other end. This string makes 2 revolutions per second around a vertical axis passing through its second end.

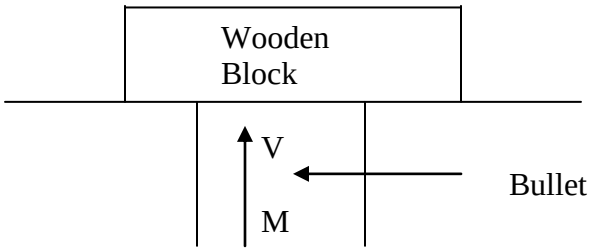
Calculate

(i) Angle of inclination of the string with the vertical. [4 marks]
(ii) The tension in the string. [2 marks]
(iii) The linear velocity of the mass. [2 marks]

Q.3 (a) State the principle of conservation of linear momentum. [2 marks]

(b) Two masses M_1 and M_2, where $M_1 = 2.0$kg, moving at 80i m/s collided with a mass $M_2 = 6.0$kg moving in the same direction at 2.0i m/s. If the collision is elastic, determines the velocities of each of the two masses after the collision. [7 marks]

(c) A bullet of mass 10g moving vertically upwards with a speed V (500 m/s) as shown embeds itself



In a wooden block of mass 2kg., to what maximum height does the block rise above its initial position? [6 marks]

Q.4 (a) (i) Define centripetal acceleration. [2 marks]

(ii) A rotating object increases its speed from rest to 25 rad s^{-1} in 10s. Find the linear acceleration of a point 0.25m from the axis of rotation. [2 marks]

(b) A cricket ball of mass 150g is moving with a velocity of $12ms^{-1}$ and is hit by a bat so that the bull is turned back with a velocity of $20ms^{-1}$. The force of the blow acts for 0.01s. Find the average force exerted on the ball by the bat. [5 marks]

(c) The driver of a train A, moving with a uniform speed of 144 kh hr^{-1} sight another train B, 1km ahead of him. The train B is moving with a uniform speed of 108 km hr^{-1}. The driver of train A immediately applies brakes producing a constant retardation and just manages to avoid a collision.

(i) What is the retardation of train A?
(ii) For how long is this retardation produced? [6 marks]

Q.5 (a) (i) State the law of universal gravitation. [2 marks]

(ii) What is the magnitude of gravitational force between a 70-kg man and a 70-kg woman separated by a distance of 10? Treat both masses as particles. [3 marks]

(b) An artificial satellite is describing an equatorial orbit at 1600 km above the surface on the earth.

(i) Calculate its orbital speed and the period of revolution. [5 marks]

(ii) If the satellite is traveling in the same direction as the rotation of the earth (i.e. from west to east). Calculate the vertically overhead to an observer at a fixed point on the equator.
(Radius of earth = 6400km). [5 marks]
