Uva Wellassa University, Sri Lanka

End Semester Examination – February/March 2011

SCT 151-1 Physics I (Repeat)

Time: One (01) hour

Total **04** Questions

Answer ALL questions

01. A child of mass 40 kg swings in a horizontal circle of radius 2.0 m by holding the end of a rope attached to a vertical post as shown in the Figure Q1. The child completes one revolution in 4.0 s.

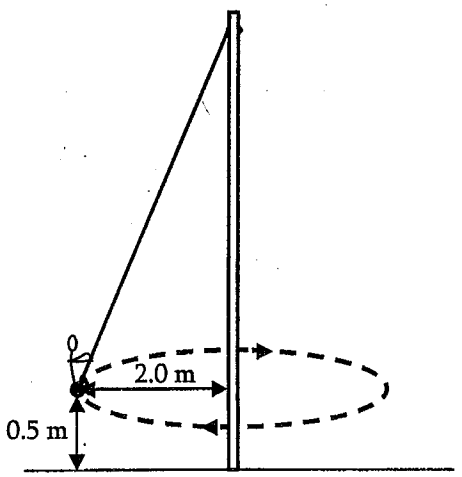

Figure Q1

(a) Find:

i. the speed of the child

(4 marks)

ii. the horizontal component of tension in the rope

(4 marks)

iii. the vertical component of tension in the rope

(4 marks)

iv. the angle made by the rope with the pole

(4 marks)

(b) The child lets go when his feet are 0.50 m above the ground. Calculate how far from the post he lands. State any assumption you made.

(9marks)

02. (a) State what is meant by the moment of inertia of a rigid object about an axis of rotation.

(5 marks)

(b) The rotor of an electricity generator in a power station can be considered as a uniform cylinder rotating about its axis. The manufacturer quotes the following data for such a rotor:

Rotor diameter	= 3.6 m
Rotor mass	= 210×10^3 kg
Moment of inertia of rotor	= 3.4×10^5 kg m^2
"Running Speed"	= 600 revolutions per minute
Time to reach running speed from rest	= 30 s

i. Calculate the angular acceleration of the rotor as it is brought from rest to its running speed. You may assume that the acceleration is uniform.

(4 marks)

ii. Calculate the torque exerted on the rotor.

(4 marks)

iii. What is the kinetic energy of the rotor at its "running speed"?

(4 marks)

iv. Due to the motion of the rotor, a nut on the surface of the rotor experiences a force. The mass of the nut is 0.80 kg. The rotor is turning at its designed running speed. Calculate the size of the force experienced by the nut.

(4 marks)

v. Explain why there is a limit to the safe running speed of the rotor.

(4 marks)

03. (a) Using the principle of conservation of angular momentum, show that the line joining a planet and the satellite sweeps equal areas at equal times when the satellite moves in an elliptical orbit around the planet.

(10 marks)

(b) Determine the ratio between the greatest and the least distances between the satellite and the planet. The maximum and the minimum velocities of a satellite which is moving on an elliptical orbit around the planet are 13.2kms^{-1} and 8.2kms^{-1} respectively.

(8 marks)

(c) Determine the least distance between the satellite and the planet, if the greatest distance is 53900km.

(7marks)

04. (a) The maximum electric field strength that air can act as an insulator is $3.0 \times 10^6 \text{ Vm}^{-1}$.

i. Write down an expression for the electric field strength E between two parallel plates separated by a distance d when the potential difference between the plates is V.

(2 marks)

ii. Two parallel plates are separated by a distance of 1.5 mm. Calculate the potential difference between the plates when insulation of the air between plates breaks down.

(2 marks)

(b) An uncharged spherical conducting sphere is placed in the region between two charged plates as shown in the Figure Q4.

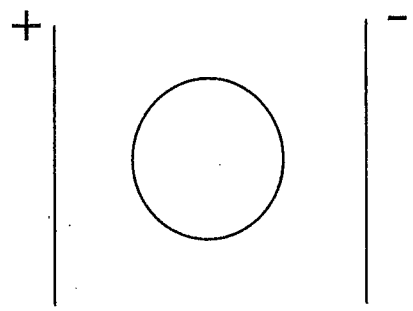

Figure Q4

i. State the nature of the electric field inside the sphere.

(3 marks)

ii. Copy the diagram.

a) Show the distribution of charge on the sphere.

b) Sketch the electric field in the region between the plates.

(4 marks)

(c) i. Obtain an expression for the electric field strength at the surface of a conducting sphere of radius R and charge Q.

(6marks)

ii. Show that the electrostatic potential V at a distance r from a point charge Q is

$$V = \frac{Q}{4\pi\varepsilon r_0}$$

(6 marks)

iii. Calculate the charge on a conducting sphere of diameter 100 mm when the potential of the sphere is 1.8 kV.

(2 marks)

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