

NATIONAL UNIVERSITY OF SINGAPORE

PC1141 PHYSICS I

(Semester I: AY 2010-11)

26 November 2010

Time Allowed: 2 Hours

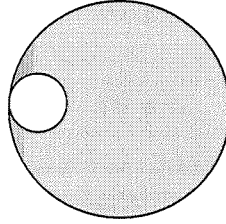
INSTRUCTIONS TO CANDIDATES

1. This examination paper contains **FIVE short** questions in Part I and **THREE long** questions in Part II. It comprises **THREE** printed pages.
2. Answer **ALL** the questions.
3. Answers to the questions are to be written in the answer books.
4. This is a **CLOSED BOOK** examination.
5. The total mark for Part I is 40 and that for Part II is 60.

PART I

This part of the examination paper contains five short-answer questions on page 2.
Answer ALL questions. The mark for each question is 8.

1. A circular pizza of radius R has a circular piece of radius $R/4$ removed from one side, as shown in the figure. Where is the centre of mass of the pizza with the hole in it?



2. A chain of mass M and length L is suspended vertically with its lowest end touching a scale. The chain is released and falls onto the scale. What is the reading of the scale when a length of chain, x , has fallen? (Neglect the size of individual links.)
3. A uniform rope of mass M and length L is pivoted at one end and whirls with uniform angular velocity ω . What is the tension in the rope at a distance r from the pivot? (Neglect gravity.)
4. A large cylindrical water tank with a small hole at the bottom is filled with water. The cross sectional area of the tank is A and the height is H . The cross sectional area of the hole is a . How long does it take to drain the tank?
5. A heavy cable of total mass M and length L has one end attached to a rigid support and the other end hanging free. A small transverse displacement is initiated at the bottom of the cable. How long does it take for the displacement to travel to the top of the cable?

PART II

This part of the examination paper contains three long-answer questions on page 3. Answer ALL questions. The mark for each question is 20.

6. Imagine that you are exploring a small airless planet with radius R . You find that if you throw a rock horizontally with speed V , it will fly in a circular orbit around the planet. Neglect the rotation of the planet.
- With what speed and in which direction should you throw a rock to make it escape from the planet?
 - Suppose that you drill a hole through the planet along a diameter. You find that the planet is roughly uniform in density. If a rock falls into the hole from the rest, will it come back? If yes, how long does it take to come back? If not, where will it be?
7. There are N men with equal mass m standing on a cart with mass M . The cart is initially resting on a frictionless floor.
- If all N men jump off the cart at the same time with a horizontal speed v_r in the same direction *relative* to the cart, what is the final speed of the cart?
 - If these men jump off the cart one by one with the same horizontal speed v_r in the same direction *relative* to the cart, what is the final speed of the cart?
 - In the above two cases, which cart speed is higher? Why?
8. A uniform solid ball with mass M and radius R is falling to the floor under the influence of gravity. Before falling, its centre of mass is at rest, but it is spinning with angular velocity ω_0 about a horizontal axis through its centre. The lowest point of the ball is at a height h above the floor. After the release, the ball rebounds to a new height such that its lowest point is αh above the floor. The deformation of the ball and the floor due to the impact is negligible. The coefficient of friction between the ball and the floor is μ . Ignore air resistance.
- If the ball is slipping throughout the impact, find the horizontal distance between the first and the second impacts.
 - Find the minimum ω_0 for the ball to slip throughout the impact.
 - If the ball stops slipping before the impact ends, find the horizontal distance between the first and the second impacts.

[Hints: The moment of inertia for a uniform solid sphere is $\frac{2}{5}MR^2$ with respect to the centre of mass; Ignore the gravity during the collision.]

----- End of Paper -----

(WQh)