

**STONY BROOK UNIVERSITY**  
**DEPARTMENT OF PHYSICS AND ASTRONOMY**

Placement Examination **Classical Mechanics**, August 31, 2006

**General instructions:** Three problems are given. You should do any two. Each problem counts 20 points and the solution should typically take less than 45 minutes. Use one exam book for each problem and label it carefully with your name, the name of the problem's author and the date. You may use a one page help sheet, a calculator, and with the proctors approval a foreign language dictionary. No other materials may be used.

**Classical Mechanics I**

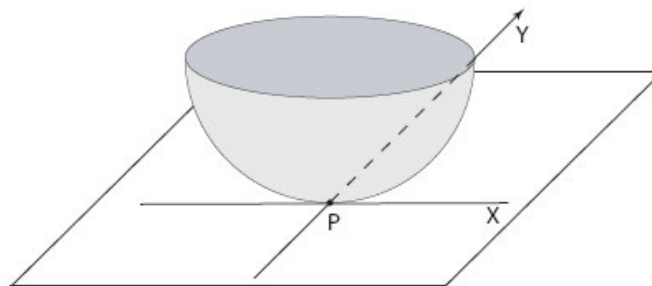
A particle is launched from afar toward a repulsive Coulomb scattering center (potential energy  $U = \alpha/r$ ,  $\alpha > 0$ ), with initial energy  $E$  and impact parameter  $b$ . Find

- a) (10 points) the nearest approach distance  $r_{\min}$ ,
- b) (10 points) the magnitude of particle's speed in the nearest approach point.

**Classical Mechanics II**

A uniform solid hemisphere of radius  $R$  and mass  $m$  is placed on a horizontal surface with finite (non-zero) friction coefficient.

- a) (3 points) Find the center of mass of the hemisphere.
- b) (7 points) Find the moment of inertia of the hemisphere with respect to an axis PX lying on the horizontal surface (see Figure).
- c) (10 points) Find the period of small oscillations of the semisphere.



**Classical Mechanics III**

A ball is bouncing vertically and perfectly elastically in a standing elevator. The maximal height of bouncing motion is  $h_0$ . The upward acceleration of the elevator is changing very slowly from 0 to  $g/2$ . Find the new maximal height of bouncing motion.