

Phys 321, Theoretical Mechanics I, Spring 2006

Homework #2

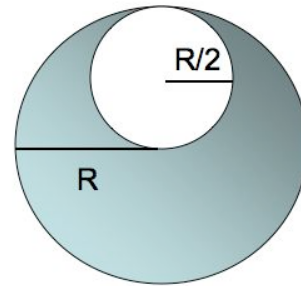
Due Date: Friday February 24, 10am

The aim of this second homework set is to help you review the concepts of Newtonian Gravity and introduce you to the Calculus of Variations.

1. Beijing, China (coordinates: 40N, 116E) is almost exactly on the other side of a diameter through the Earth's core that starts in Buenos Aires, Argentina (coordinates: 34S, 58W). If we could open a narrow tunnel through the Earth along this diameter and let a bowling ball of mass m fall with zero initial velocity into the tunnel from Buenos Aires, how long will it take for the ball to reach Beijing? Assume that the Earth is spherical and non-rotating, that the density in the interior of the Earth is constant, and take the mass of the Earth to be 6×10^{24} kg and its radius to be 6^6 m.

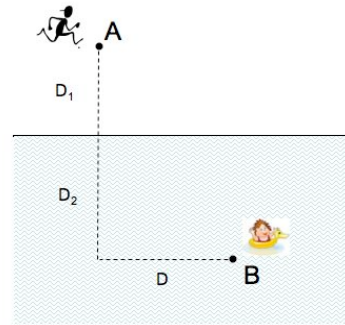
Calculate the magnitude and direction of the gravitational field in the center of a sphere of radius R and uniform density ρ , out of which we have curved out a spherical hole of radius $R/2$, as shown in the figure.

2.



A lifeguard is sitting on a beach (point A in the figure) and wants to save a distressed swimmer in the ocean (point B) in the figure. The lifeguard can run on the beach at a speed V_r and swim at a speed V_s . What is the optimal path for the lifeguard to take in order to reach the swimmer at the shortest amount of time? **For Honors students:** Solve this problem using Calculus of Variations

3.



1-point bonus for everyone: Consider a spherical and an oblate object of the same mass M and four points (A, B, A', and B') as shown in the figure, all at the same distance R away from the centers of the objects.

4.

