

The University of Georgia
Department of Physics and Astronomy
Graduate Qualifying Exam — Part I
8 August 2016

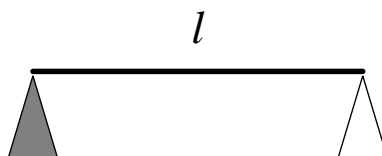
Instructions:

- Attempt all problems. You *must* show your work and/or clearly explain your answers in order to be able to earn a passing grade for a problem.
- Start each problem on a new sheet of paper. Write the problem number on the top left of each page, and your pre-arranged **prelim ID** number (but *not* your name) on the top right of each page. Leave margins for stapling and photocopying.
- This is a closed-book exam. You are permitted to bring one page of notes (equations, definitions, physical constants, etc.) per exam day. You must hand in this page of notes with the exam each day.
- You may use a calculator, but *only* for arithmetic functions (i.e., not for referring to notes stored in memory, doing symbolic algebra, etc.).

Part I has five problems, numbered 1–5.

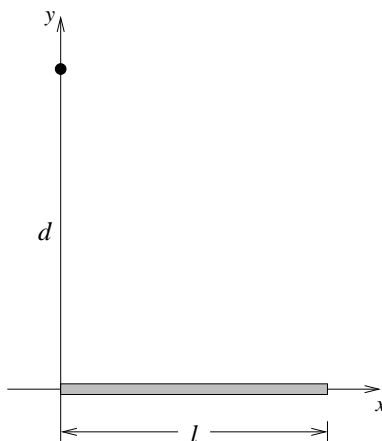
Problem 1: (one part)

A uniform thin rod of length ℓ and mass m rests on supports at its ends. The right support is quickly removed. Immediately thereafter, what is the force on the rod from the left support?



Problem 2: (one part)

A thin, uniformly charged rod of length ℓ located along the $+x$ axis has a total charge Q . Find the electric potential at a point P along the $+y$ axis a distance d from the origin.



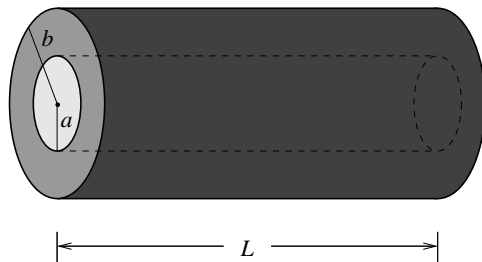
Problem 3: (two parts)

Consider a rocket in deep space, initially at rest in an inertial reference frame. The rocket's engine can produce exhaust at a speed V relative to the rocket. The engine is to be fired for a certain interval of time T .

- What should be the rocket's *mass ratio* (ratio of initial to final mass) over that interval, if the rocket's final speed is to be equal to the exhaust speed V ?
- What should the mass ratio be if the rocket's final speed is $4V$? Compare your answer to the previous part.

Problem 4: (one part)

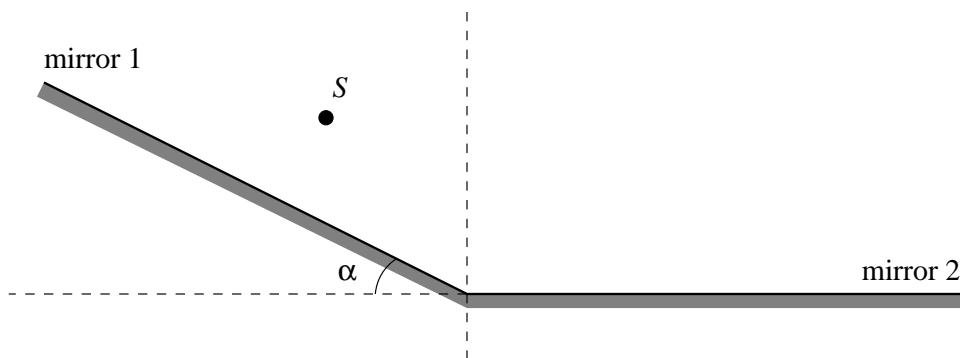
Two long coaxial metal cylinders (with radii a and b) are separated by material of conductivity σ . If they are maintained at a potential difference V , how much current flows from one cylinder to the other, in a length L ?



Problem 5: (two parts)

The Law of Reflection states that (1) the angle of incidence equals the angle of reflection, and (2) the incident ray, reflected ray, and normal are coplanar. Based on this law, for a plane mirror, one immediately finds that the image of an object is on the opposite side of the object's location with respect to the mirror. Furthermore, the distance of an image to the mirror equals the distance of the object to the mirror.

Two plane mirrors are placed together as shown below. A point source S is placed in front of these mirrors, somewhere to the left of the vertical line perpendicular to mirror 2 and passing through the mirror intersection point.



- Show that the point source S and its two images — formed by direct incidence of light rays on these two mirrors — lie on a circle. Find where the center of that circle is located in the figure.
- Indicate on the figure the region in front of the mirrors where an observer should stand to be able to see both of the images from part (a). Briefly explain your reasoning.