

Physics 7b
Fall 2004
Midterm 2
Packard

Work all problems. All problems are worth the same number of points. Introduce and clearly define algebraic symbols. Do not perform numerical work until you have a final algebraic answer within a box. Check the dimensions of your answer before inserting numbers. Work the easiest problem first, and the next hardest, etc. If you do not understand the question ask the proctor for assistance. Do not quit until you are POSITIVE you can't work any more of the problems.

$$F = -dU/dx$$

Name: _____ SID _____

D/L section _____ Time at hand in _____

1. _____

2. _____

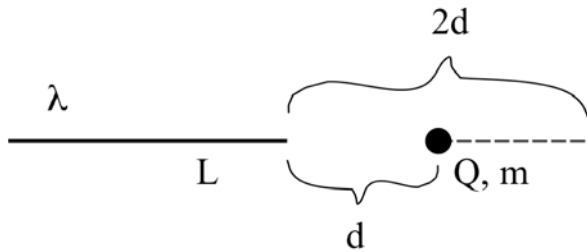
3. _____

4. _____

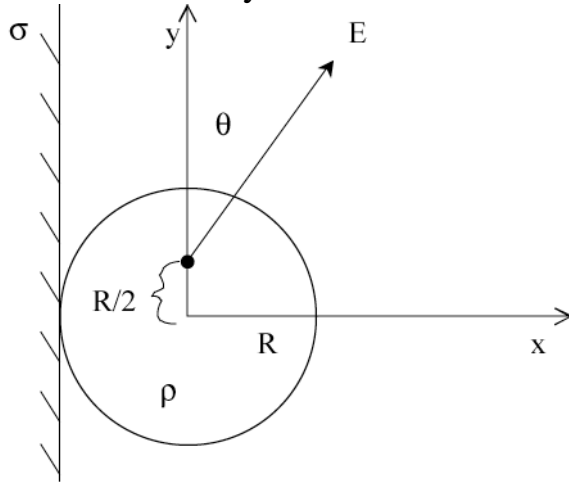
5. _____

6. _____

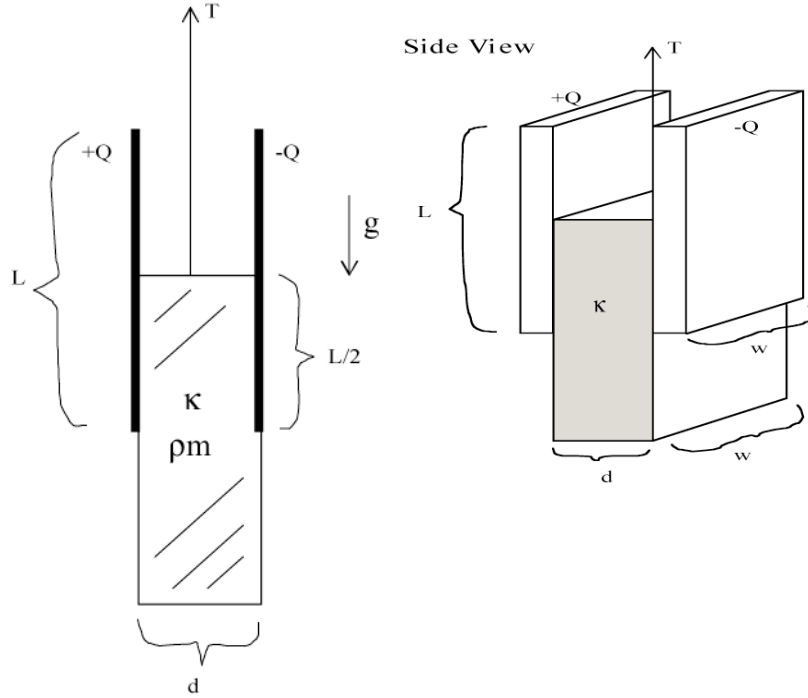
1. A charge is distributed uniformly with charge density λ along a line L meters long. A charge Q with mass m is released from a point d meters away from the end of the line. Find the particle's speed when it reaches a position $2d$ from the end of the line charge.



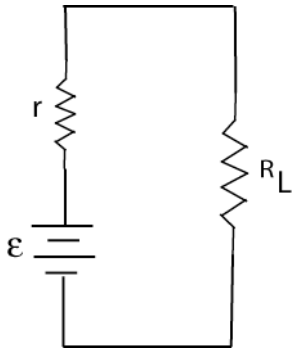
2. A uniformly charged sphere (charge density ρ) with radius R is located adjacent to, and just touching, an infinite conductor with surface charge density σ . Locate a coordinate system at the center of the sphere with the vertical y axis running parallel to the conductor and the x axis running perpendicular to the conductor. Find the direction of the electric field at the point $x=0, y=R/2$. Specify your answer by finding the angle, θ between the \mathbf{E} vector and the y axis.



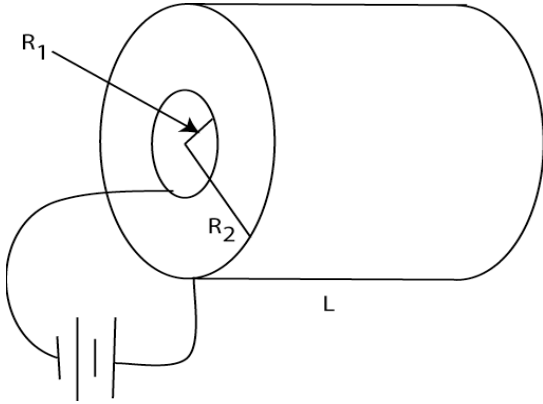
3. An insulating slab with dielectric constant κ , mass density ρ_m , thickness d , length L , and width w is halfway up a parallel plate capacitor with gap d , height L , and width w . The slab is suspended in the Earth's gravity by a thread. What charge Q must be on the capacitor for the tension, T , in the thread to be zero? (Hint: force is the negative derivative of energy with respect to position.)



4. Your first engineering job is to design an electric heater that runs off of a battery with internal resistance r . You need to choose the value of the heater wire resistance R_L so that the battery can deliver the maximum power to the wire. You realize that if R_L is zero, no power will be delivered. Also, if R_L is infinite there will also be zero power delivered. What is the value of R_L (somewhere between 0 and ∞) that dissipates the maximum power? Prove your answer.



5. A solid cylindrical resistor of radius R_2 , length L , and resistivity ρ , has a hole drilled along its axis of radius R_1 . Find the resistance for the radial direction of current flow. You may assume that the outer and inner cylindrical surfaces are equipotentials, i.e. imagine they are covered with a metallic coating.



6. A $50\mu\text{A}$ (full scale) galvanometer has an internal series resistance of $r=30\Omega$. This galvanometer is used to make a voltmeter which reads 2 volts full scale. The voltmeter is used to measure the voltage across one of two 1megohm resistors, R , which are connected in series across a 3 volt battery. What voltage does the meter register on the scale?

