PHYS 4392 Exam 1

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Fall 2014

Printed Name _____

DIRECTIONS:

1. If I can't read it, I can't grade it.

2. **Show** your work to receive credit.

3. **BOX YOUR FINAL ANSWERS**

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5. Paginate all pages. Label the problem number clearly.

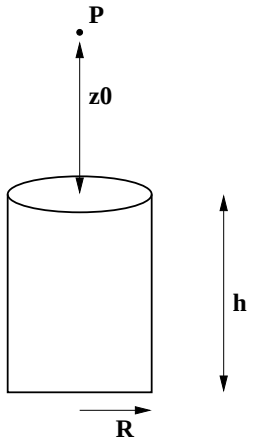
6. Staple your pages together, in order.

7. Good luck.

Q1 10 pts. A total charge Q is placed on a uniform, perfectly conducting spherical balloon of initial radius R_0 and total, fixed mass m_B. The balloon is initially constrained so that its radius is fixed. At time $t = 0$ the constraint is released without disturbing the spherical shape of the balloon. Assuming the skin of the balloon does not break and offers no resistance to either stretching or shrinking, what is the final radial speed $v_f = (dr/dt)_f$ of the balloon skin? Indicate also, possibly with a simple sketch, the radial direction of motion of the balloon skin. (That is, does the balloon expand outward or inward?) Ignore the effects of gravity. Hint: Figure out the force on the balloon or a piece of it. Recall from the chain rule that $d^2r/dt^2 = dv/dt = (dv/dr)(dr/dt) = v\,dv/dr$. (You have seen this trick in PHYS 1304!)

Q2 10 pts. What is the capacitance C of two concentric conducting spherical shells? Let the radius of the smaller shell be r_1 and the radius of the larger shell be r_2.

Q3 10 pts. A thin metallic tube of radius R and length h carries a charge Q. What is the potential V at a point on the symmetry axis of the tube at a distance z_0 from the center of the top rim of the tube? See the figure below. Express V in terms of z_0, R and h. The integral $\int dx/\sqrt{a^2+x^2} = \ln(\sqrt{a^2+x^2}+x)$, where a is a constant, is useful.



Q4 10 pts. Four identical charges Q are placed at the corners of a square. A 5th charge charge q is brought to the center of the square. Determine q such that there is no force on any of the charges. Think symmetry!

Q5 1 pt. Extra credit. Name an English word that represents a number and has all its letters in alphabetical order. (For example, "eighteen" represents the integer 18 but the letters are not in alphabetical order.)