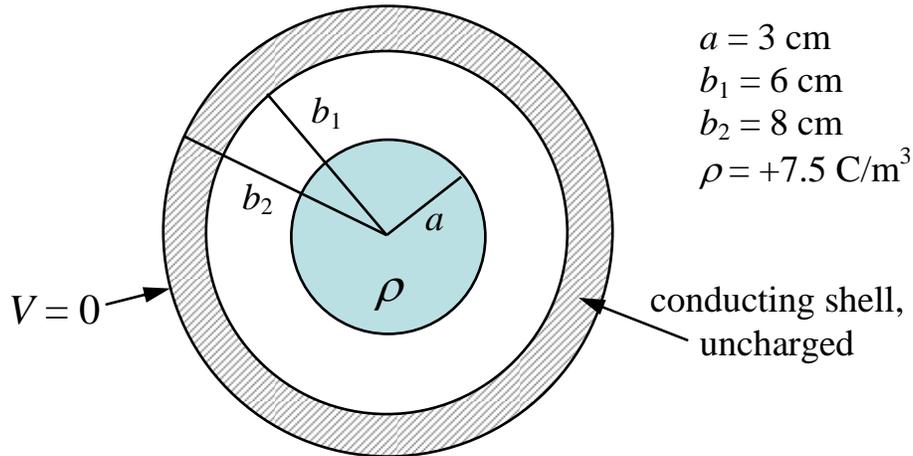


Discussion Question 4B

P212, Week 4

Electric Potential in a System with Cylindrical Symmetry

Consider a non-conducting cylinder of infinite length and radius a , which carries a volume charge density ρ . Surrounding this object is an uncharged conducting cylindrical shell. The metal tube is also of infinite length, and its inner and outer radii are b_1 and b_2 respectively. In this problem, we will define the potential to be **zero** at the outer surface of the conducting shell.



(a) What is the electric potential at a radius of 10 cm from the center of the cylinders?

- (i) In all of these potential problems, we have to integrate the electric field from a point where we *know* the potential to the point we are interested in. In this problem, we want the potential at a point 10 cm from the axis of symmetry ... let's call this point 'A'. Now, where do we *know* the potential? Write down an expression for V_A (the quantity we want) in terms of a potential we know and an integral over the electric field.

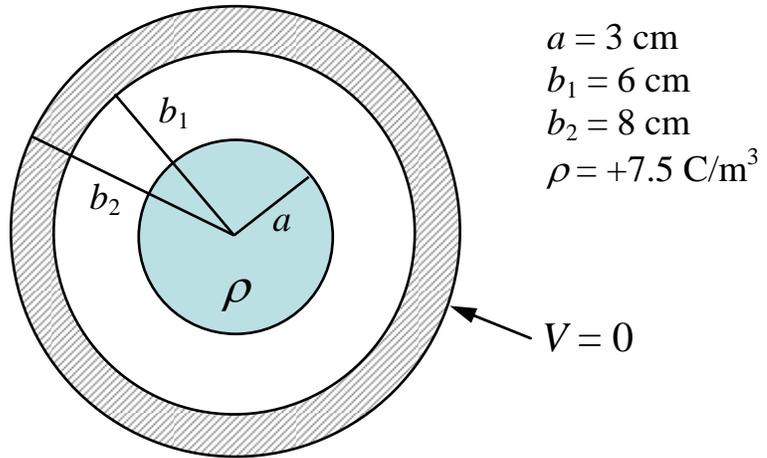
- (ii) Now that our integral is set up, we need to know the electric field \mathbf{E} , in all regions over which we have to integrate. Write down an expression for \mathbf{E} .

- (iii) Solve the integral!

- (iv) This is **important**: check the sign of the integral you just solved using your physical intuition: If we're moving 'downhill' (i.e. along the electric field), the electric potential *drops*. If we've gone 'uphill', the electric potential should have *increased*.

(b) What is the electric potential at a radius of 7 cm?

(v) Here we go again. We'll call our new point of interest 'B'. Write down an expression for V_B in terms of a known potential and an integral over the electric field.



(vi) Now you need the electric field \mathbf{E} . What could it be ...?

(vii) Solve the integral ... (this is too easy)

(viii) By the way: what *general statement* can you make about the electric potential inside a *conductor*?

(c) What is the electric potential at the center of the non-conducting cylinder?

Same procedure, just a bit more work than before ...

(d) It is customary to use infinity as a reference point, and set the potential to zero there. Why could we *not* choose infinity as the zero of potential in this particular problem?