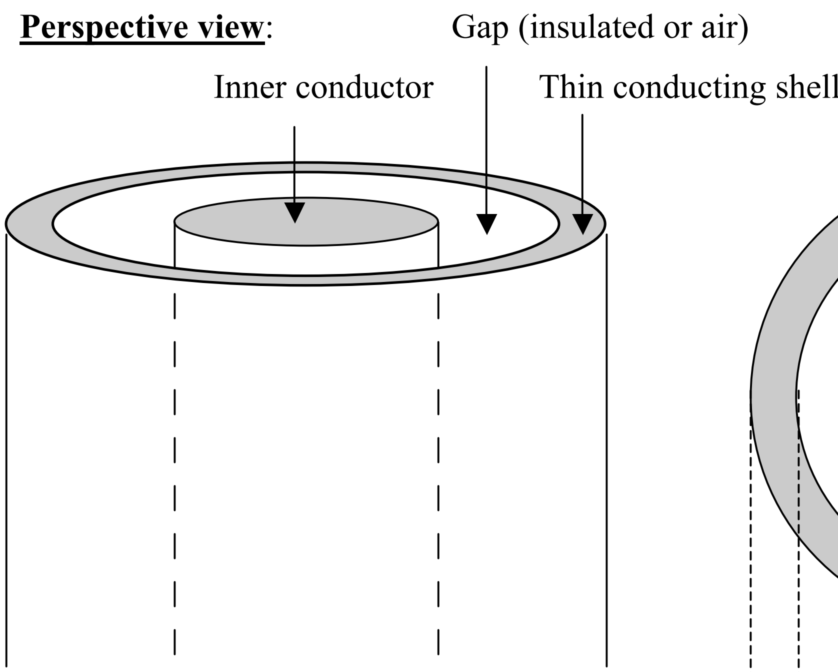
Part 1 – Conceptually Understanding Conductors

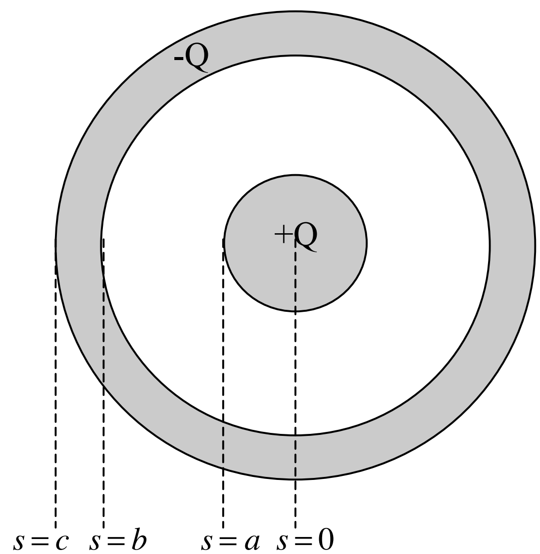
A coax cable is essentially one long conducting cylinder surrounded by a conducting cylindrical shell (the shell has some thickness). The two conductors are separated by a small distance. (Neglect all fringing fields near the cable's ends)

i. Draw the charge distribution (little + and – signs) if the inner conductor has a total charge +Q on it, and the outer conductor has a total charge –Q. Be precise about exactly where the charge will be on these conductors, and how you know.

Perspective view:



Top view:



ii. If you were calculating the potential difference, ΔV, between the center of the inner conductor ($s=0$) and infinitely far away ($s=\infty$), what regions of space would have a (non-zero) contribution to your calculation?

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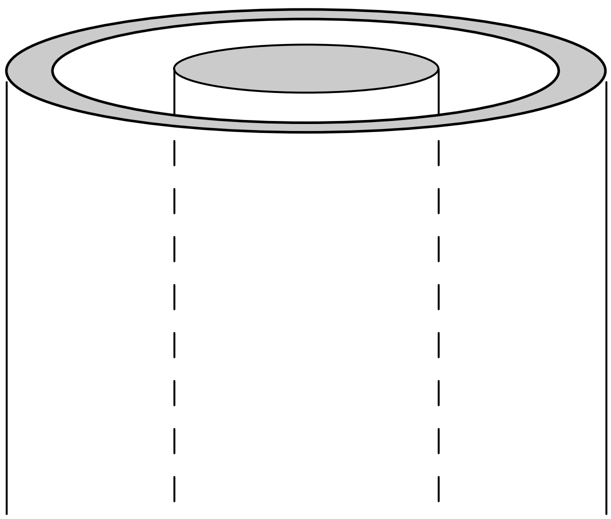
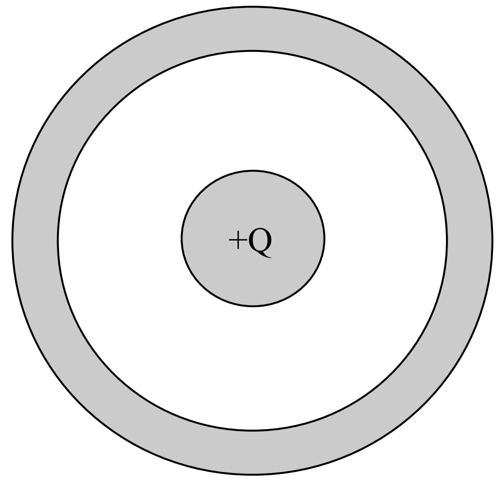
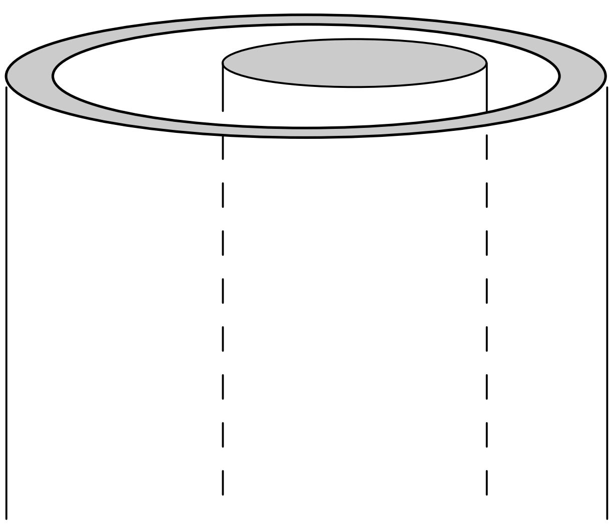
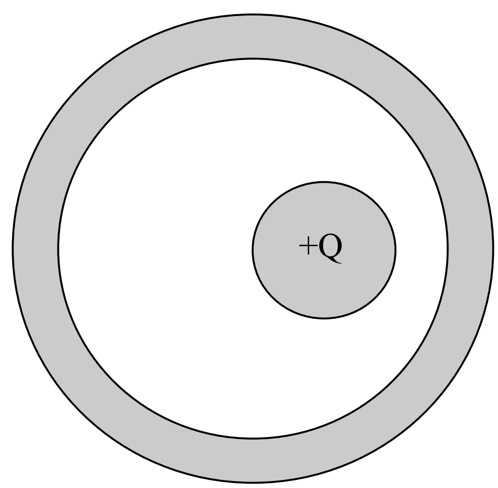
iii. Now, draw the charge distribution (little + and – signs) if the inner conductor has a total charge +Q on it, and the outer conductor is electrically neutral. Be precise about exactly where the charge will be on these conductors, and how you know.





iv. Consider how the charge distribution would change if the inner conductor is shifted off-center, but still has +Q on it, and the outer conductor remains electrically neutral. Draw the new charge distribution (little + and – signs) and be precise about how you know.





(This is very similar to the asymmetry on HW5Q4f)

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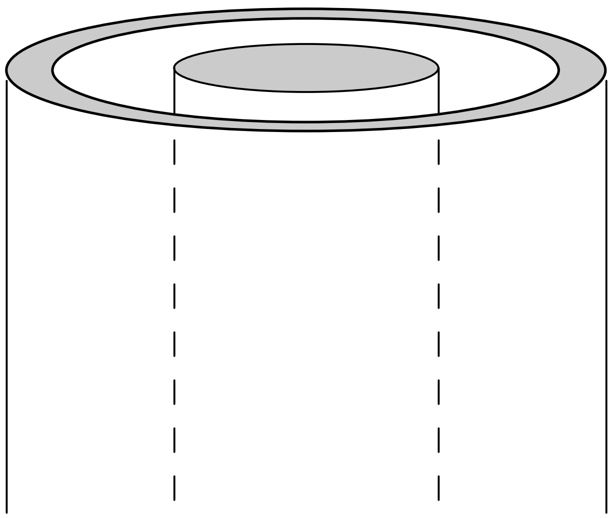
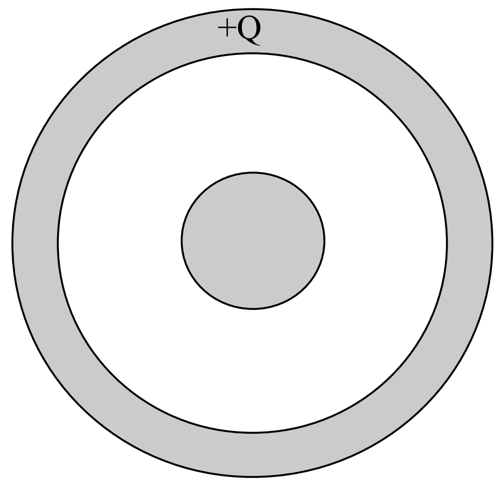
v. Now, instead of the total charge +Q being on the inner conductor, sketch the charge distribution (little + and – signs) if the *outer* conductor has a total charge +Q on it, and the inner conductor is electrically neutral. Be precise about exactly where the charge will be on these conductors, and how you know.





vi. What is the potential difference, ΔV, between the center of the inner conductor ($s = 0$) and the outer conductor ($s = c$)?

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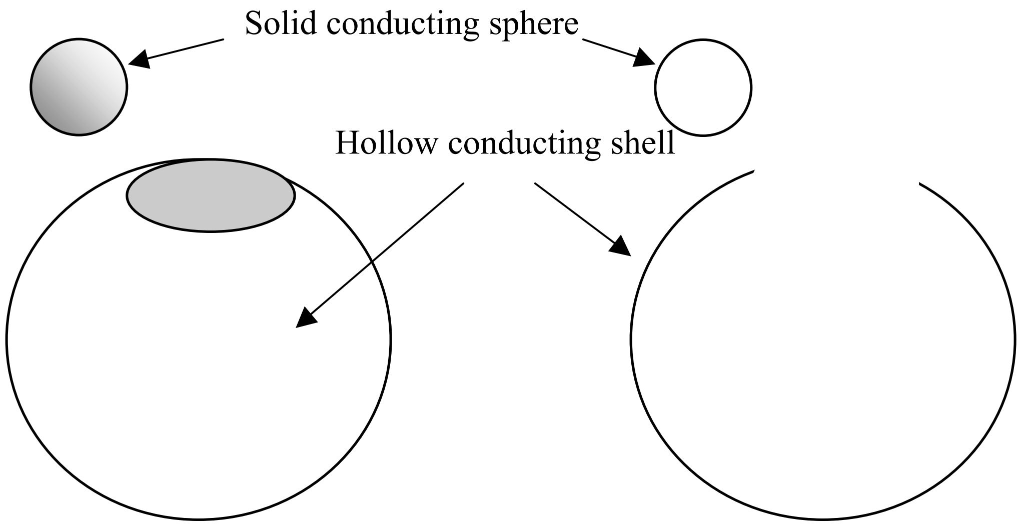
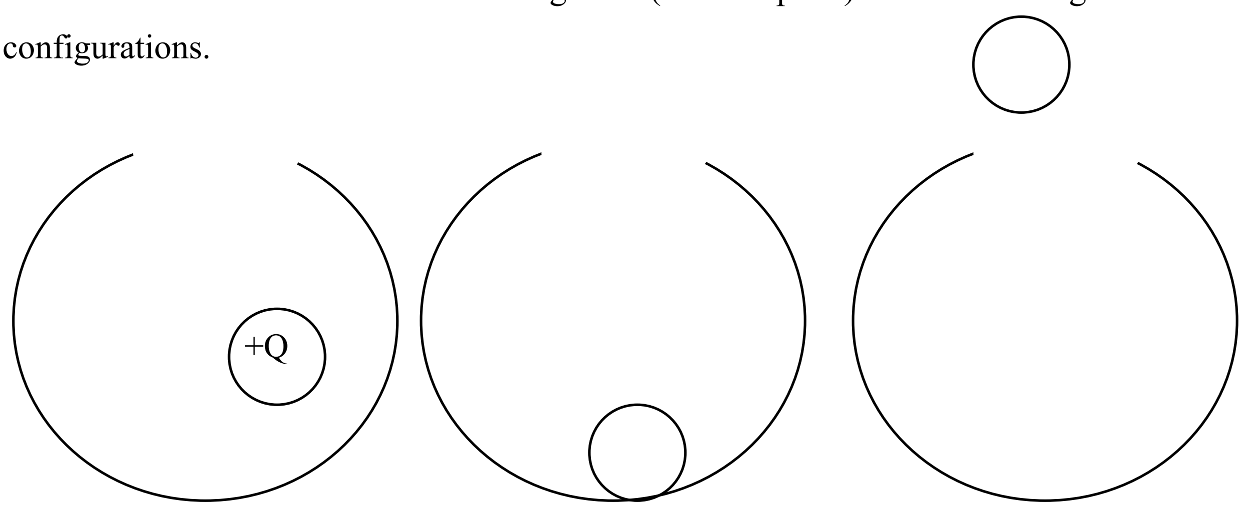
Part 2 – Faraday's Ice Pail

Faraday's Ice Pail –originally a metal pail and suspended metal ball– helped early physicists understand conductors and shielding. It consists of a hollow conducting shell, with a hole cut out to allow a smaller conducting sphere to fit inside.

<u>Perspective view</u>: **<u>Profile view</u>:**



i. Consider this: the conducting shell starts out electrically neutral, but the small sphere inside of it has a total charge +Q. Based on your previous answers, what does the charge distribution look like before, during, and after, if the small solid sphere makes contact with the inside surface of the conducting shell (the "ice pail"). Draw the charge configurations.



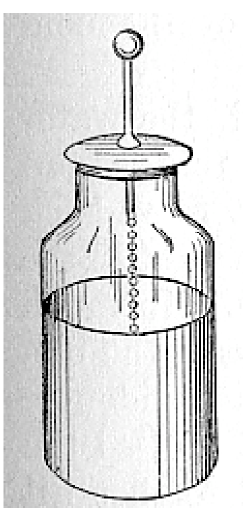
Before contact During contact After contact

Part 3 – Capacitors

A parallel plate capacitor is made of two conductors that each have area A, and are separated by a distance D. There is a potential difference of 100,000V between the plates. (Neglect fringing fields near the edges)

i. There are two ways to find the work required to assemble this charge configuration. **Do not actually find the work**, but outline the two ways you could, using the given information.

(You will calculate the stored energy of a capacitor in two different ways on HW5Q5)



The original capacitor is the Leyden jar. The name "Leyden" comes from the town "Leiden" in the Netherlands, which is the location of the university where it was invented in 1745. Leyden jars were used for early electric experimentation. Think about where charge accumulates as you watch this demo.

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