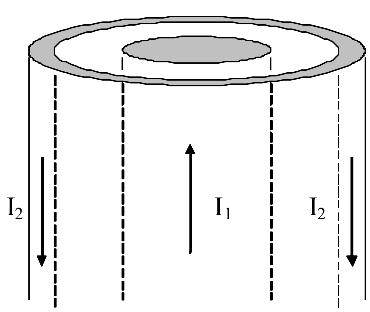
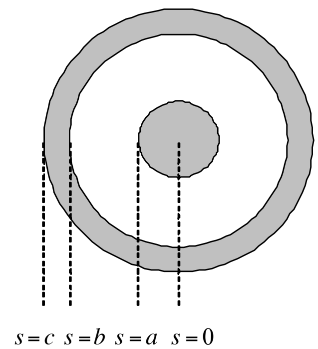
# ✯ TUTORIAL 9: UNPACKING AMPERE'S LAW ✯

Coaxial cables are essentially one conducting cylinder surrounded by a thin conducting cylindrical shell (the shell has some thickness). At some moment in time current is traveling up the inside conductor, and back down the conducting shell. We want to calculate the magnetic field at different radii.

*Perspective view:*




*Top view:*



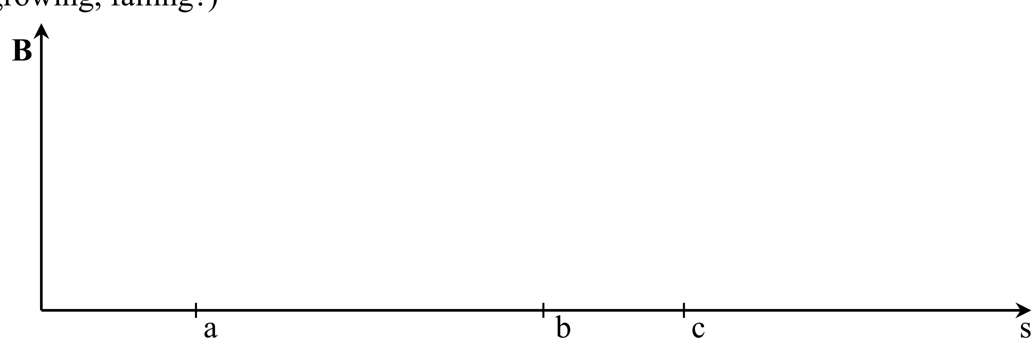

Ohm's law for a wire says: Resistance ∝ Length/(Cross-Sectional Area). Thus the current density **J** is uniformly distributed throughout the body of a conducting wire (i.e. not only on the outside or concentrated at the center).

i. Before you do any calculations, think about what answers you expect in the following questions a, b, and c.

a) Is there a magnetic field inside either of the two conductors?

b) How should $I_1$ and $I_2$ compare in order to produce no magnetic field outside of the coax?

c) For the case of $|I_1| = |I_2|$, sketch a *qualitative* graph of **B** in the four regions: s < a, a < s < b, b < s < c, and s > c. Try to do this *without* solving the problem first! (e.g., is B zero, growing, falling?)







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ii. Now, using your model for **J** from question i in this section, calculate **B** in the four regions (you may assume $I_1$ and $I_2$ have the same magnitude *I*):

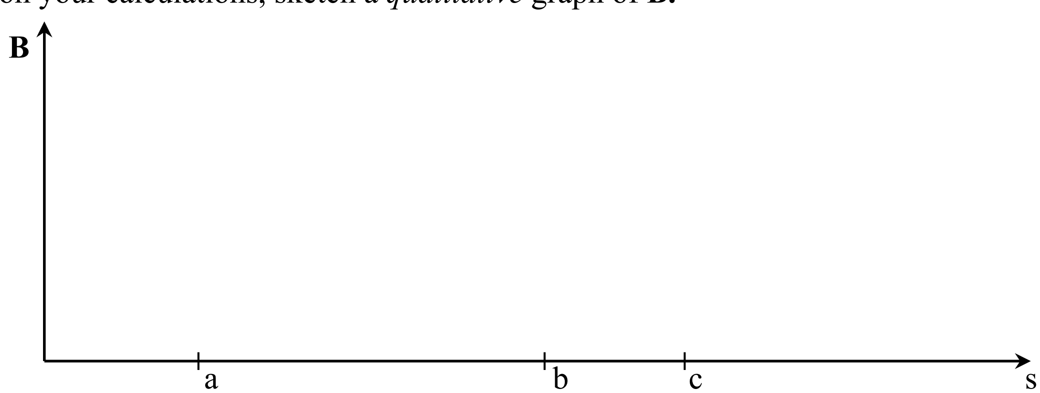
a) $s < a$

b) $a < s < b$

c) $b < s < c$

d) $s > c$

Based on your calculations, sketch a *qualitative* graph of **B.**




How does this graph compare with you prediction in part ii?



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