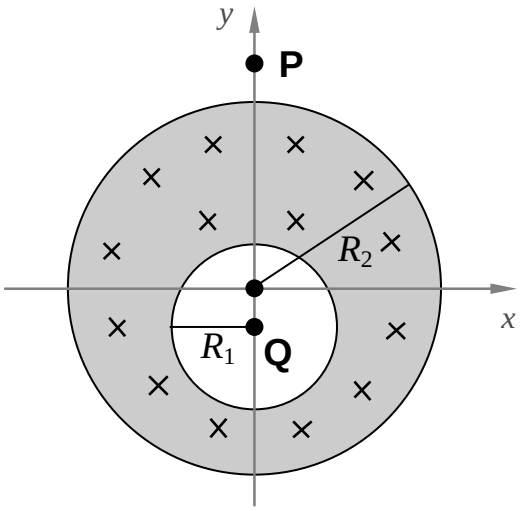
Discussion Question 9B
P212, Week 9
Magnetic Field due to an Asymmetric Hollow Cylinder

A conducting cylinder is oriented parallel to the *z* axis and carries a uniform current *I* in the negative *z* direction (into the page). This cylinder is hollow, however, with a cylindrical bore centered on the point **Q** shown in the figure. The radius of this bore is R_1, while the outer radius of the cylinder is R_2.

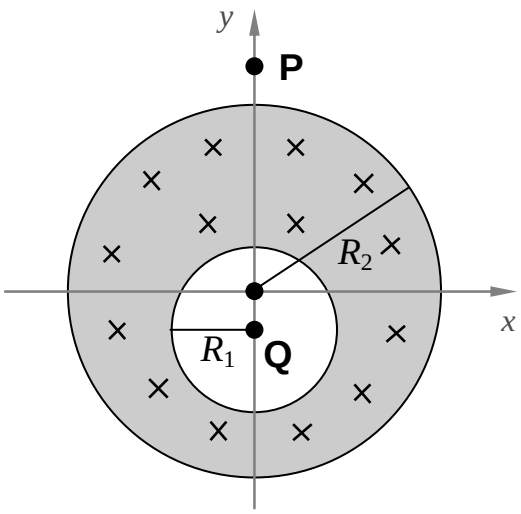


I = 2.5 A into page
R_1 = 5 cm
R_2 = 12 cm
point **P**: y = 15 cm
point **Q**: y = -3 cm

(a) Calculate the magnetic field at the point P on the *y* axis.

(i) This appears to be a horrendous problem, with no symmetry! But really, the hollow cylinder is a *superposition* of two solid cylinders ... and a solid cylinder of current is something we can deal with. How could you treat this system so that it consists of two solid cylinders?

(ii) Calculate the field at point **P** due to each of the two cylinders, then add the two contributions together. Remember to work by *components* since you are adding field *vectors*.



I = 2.5 A into page
R_1 = 5 cm
R_2 = 12 cm
point **P**: y = 15 cm
point **Q**: y = -3 cm

(b) Calculate the magnetic field at the point Q at the center of the hollow bore.

Again, compute the field due to each of the two cylinders separately, then add the fields together. This time, one of the contributions will be very easy .... but one of them requires a little more thought. What is the *enclosed current* that goes into Ampere's Law?