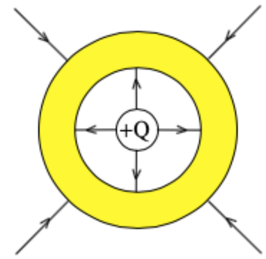
Note: Some of this question came from (or was inspired by) the "Frensley Physics" YouTube site:



A hollow, conducting, spherical shell has a charged sphere +Q at its center. The electric field lines for the system are shown.

a.) What is the net charge on the conducting spherical shell? Justify.

--if you draw a Gaussian surface outside the entire complex, you will find a negative flux (the field lines are pointed inward);
--a negative flux is the consequence of a net negative charge inside the Gaussian surface, so the net charge on the conducting spherical shell must be negative

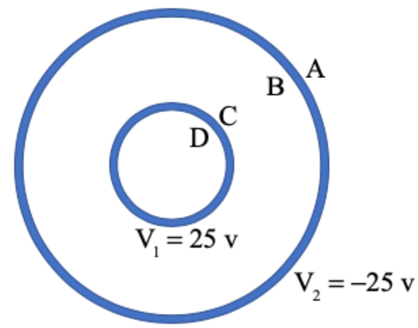
b.) Is the magnitude of the net charge on the conducting spherical shell small, equal to or greater than Q? Justify.

--for the net charge to be negative, the charge on the conducting spherical shell must be negative and it must have a magnitude larger than Q (otherwise, the net charge inside the Gaussian surface would not yield an inward flux).

c.) A student argues that the conducting sphere is an insulator. What would have to be true for that assertion to be true. Explain.

--to have no electric field inside the shell, Gauss's Law maintains that the net charge enclosed inside a Gaussian surface must be zero;
--to have no electric field inside the insulator, then, there must be a net charge of -Q on the inside surface of the shell—in that way, a Gaussian surface inside the shell will have zero net charge enclosed, and the electric field inside the insulator would be zero;
--to have field lines outside the insulator, there would have to be negative charge on the outside surface, also.
--if the number of field lines is any indication, the amount of negative charge on the outside surface would be the same in magnitude as Q (there are the same number of field lines coming into contact with the shell in both regions . . .)

d.) New situation: The set-up is replaced by two, concentric, spherical conducting shells. The outside shell has a voltage, relative to infinity, of -25 volts, and the inner shell has a voltage of +25 volts. A point just outside the outer shell is identifies as Point A, just inside the outer shell as Point B, a point just outside the inner shell as Point C and a point just inside the inner shell as Point D.



i.) What are the charges on the shells? Justify.

--negative voltages are generated by negative charges, so the outside shell must have a negative charge on it;
--if the inside shell had been negative, it also would have been negative—it isn't, so the inside shell must be positively charged;

ii.) Which charge is larger?

--the electric field outside is inward (zero volts at infinity, -25 volts at outer shell—electric fields go from higher voltage to lower, and -25 is lower than zero);
--the electric field between the shells is outward as electric fields go from higher voltage to lower voltage;
--putting a Gaussian surface around the entire structure, the net electric field must be negative (hence the inward field);
--but that Gaussian surface will enclose the charge on both the inner and outer shells, so the outer negative shell must have more charge on it.

iii.) Rate the electric field magnitudes in order of smallest to largest, justifying each choice.

D , B , A , C
--easiest to see is the field at D—Gaussian surface through D will have no charge enclosed, so the field there is zero;
-- C > B because the Gaussian surface in between the shells has the same charge enclosed, but because C is closer to the charge on the shell, C's field will be larger;
-- B > A because the radius of the two points is approximately the same, but a Gaussian surface through A will have less charge enclosed because some of the charge will be positive (from the inner shell) and some negative (from the outer shell), so the sum will be less than just the positive charge on the inner shell, which is what the Gaussian surface through B will enclose.
--crazy, eh?