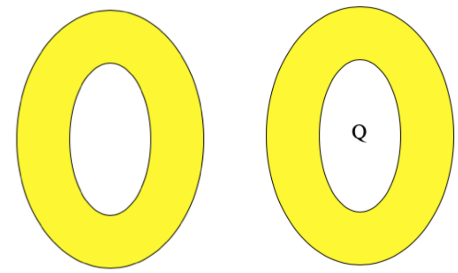
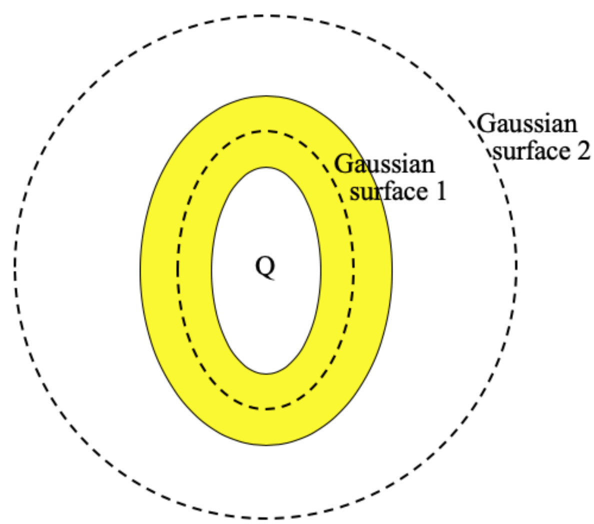
Off-the-Wall question #1: The cross-section of an electrically neutral, conducting, thick skinned, spherical shell that has been pulled into an oval shape sits in space (see first sketch). A shielded charge Q (that is, a charge that cannot affect its surroundings) is suspended at its geometric center (see second sketch).



a.) At a particular instant, the shielding around Q is removed. What, physically, is going on inside the conducting shell as that happenings (that is, during the first few instances after the shielding is removed).

--an electric field will momentarily be set up in the conductor causing electrons to rearrange themselves;
--the electrons will move until the electric field goes to zero;
--in this case, that will happen when Q's worth of electrons distribute themselves on the inside surface of the conductor;
--due to the shape, this distribution will not likely be uniform with more electrons accumulating along the x-axis where they will be closer to the charge and fewer along the y-axis where they will be farther away.

After some long period of time, two closed, imaginary, Gaussian surfaces are placed as shown in the final sketch.



b.) The magnitude of the amount of charge residing on the inner surface of the shell is:

___ zero ____ less than Q _x__ equal to Q

___ greater than Q ___ cannot be determined due to geometry

Using what has been provided to you in the sketch (i.e., the Gaussian surfaces), justify your response.

--the electric field inside a conductor will (after that initial bit of chaos) be zero;
--electric flux through a differential area of the Gaussian surface S1 will be defined as the dot product of the electric field evaluated at the point of the area vector and the area vector;
--if the electric field at that point is zero (which it is—it's inside the conductor), the electric flux will be zero;
--summing all those zero flux quantities over the entire surface will yield zero electric flux through surface S1;
--Gauss's law states that the electric flux through a surface will be proportional to the charge enclose within the surface;
--because the electric flux is zero, the net charge must be zero . . . which means the charge on the inner surface must be -Q . . . which has a magnitude of Q.

c.) Will Gauss's Law work with Gaussian Surface 2? Justify your response.

--interesting question: yes!
--Gauss's Law ALWAYS works—if you have a closed surface of any form, the net flux through the surface will be proportional to the charge enclosed inside the surface;

d.) Can you use Gaussian Surface 2 to determine the electric field function for the region outside the shell? Justify your response.

--for Gauss's Law to be useful, a Gaussian surface must be used that has the magnitude of E the same everywhere;
--why is this important?
--if the magnitude of E isn't the same everywhere on the chosen surface, you can't pull it out of the integral on the left side of Gauss's Law (that is the beauty of the approach—by pulling that factor out, you end up with the sum of all the differential areas, which is just the total surface area of the Gaussian surface);
--to satisfy this need, your Gaussian surface needs to exploit symmetry;
--for this problem, because the charge on the outside of the conductor in the region around the y-axis is *closer to the Gaussian sphere* than is the charge in the area around the x-axis, the magnitude of E, evaluated on the Gaussian surface in the vicinity of the y-axis, will differ from the magnitude of the E evaluated on the Gaussian surface in the vicinity of the x-axis;
--in short, there is not the symmetry needed to make Gauss's Law work in this case.

e.) Someone places 2Q's worth of charge from an external source on the outside surface of the shell. After rearrange itself, the charge that is found on that outside surface will have distributed itself in what way? That is, will it:

___ distribute itself uniformly over the outside of the shell?

___ distribute itself with more charge per unit area close to the horizontal axis?

_x__ distribute itself with more charge per unit area close to the vertical axis.

Justify your response.

--this is a shielding problem;
--the more the curvature of the structure, the more charge will accumulate on the surface;
--as the surface is more curved at the top and bottom (along the y-axis), you should find more charge on the conductor in the vicinity of that axis.