A rubber balloon has a single point charge in its interior. Does the electric flux through the balloon depend
on whether the balloon is fully inflated?

Consider a point charge $Q$. If the electric field due to this point charge was of the form

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^3}\hat{r}$$

that is, it depends inversely as the cube of the distance, would Gauss’s Law still be valid? Explain your reasoning.

For simplicity consider a spherical Gaussian surface centered on the charge.

A conducting spherical shell with inner radius $a$ and outer radius $b$ has a positive point charge $Q$ located
at its center. The total charge on the shell is $-3Q$ distributed uniformly in angle, and it is insulated from the
surroundings.

a) What is the appropriate Gaussian surface to use for calculating the electric fields in this system? Explain
why.
b) What are the regions of space that should be considered separately in order to calculate the electric fields
in the system? Explain why.
c) Where does the charge reside on the conductor?
d) Calculate the electric field in the space both inside and surrounding this system.
e) Graph the electric field as a function of radius.

A long conducting cylindrical shell with radius $a$ carrying a linear charge density $+\lambda$ coulombs/meter, is
surrounded by an equally long conducting cylindrical shell of radius $b$ carrying a linear charge density of $-2\lambda$
coulomb/meter.

a) What is the appropriate Gaussian surface to use for calculating the electric fields in this system? Explain
why.
b) What are the regions of space that should be considered separately in order to calculate the electric fields
in the system? Explain why.
c) Where does the charge reside on the conductors?
d) Calculate the electric field in both the space inside and surrounding this system.
e) Graph the electric field as a function of radius.

Consider a thin circle of radius $a$ carrying a total charge $Q$ uniformly distributed around the ring. Assume
that the ring is concentric with the $x$ axis.

a) Derive the electric field on the $x$ axis at a distance $x$ from the center of the ring by using the field due to an
element $dq$ and integrating around the ring.
b) Sketch what the electric field will look like off the $x$ axis.
c) Is Gauss’s Law obeyed for this system and could you have used it to easily derive the electric field? If so
what Gaussian surface would you have chosen?