Quiz 2: Gauss

\[ \mathbf{E} = \frac{kq}{r^2} \hat{r} \] point charge
\[ \Phi_E = \oint_{S} \mathbf{E} \cdot \hat{n} \, dA = 4\pi k e q_{\text{enclosed}} \]
\[ \oint_{S} \mathbf{E} \cdot \hat{n} \, dA = |\mathbf{E} \cdot \hat{n}| A_{\text{surf}} \] (clever surface)

1. If the net flux through a closed surface is zero, the following four statements could be true. Which of the statements must be true?

☐ There are no charges inside the surface
☐ The net charge inside the surface is zero
☐ The electric field is zero everywhere on the surface
☐ The number of electric field lines entering the surface equals the number leaving the surface

2. A point charge \( q \) is located at the center of a spherical shell of radius \( a \) that has a charge \( -q \) uniformly distributed on its surface. Find the electric field for a point a distance \( r > a \) from the center of the shell (i.e., outside the sphere).

☐ \( E = \frac{kq}{r^2} \)
☐ \( E = \frac{kq}{4\pi r^2} \)
☐ \( E = 0 \)
☐ \( E = \frac{kq^2}{r^2} \)

3. A spherical surface surrounds a point charge \( q \). Describe what happens to the total flux through the surface if the charge is moved outside the surface

☐ The flux is increased.
☐ The flux is decreased.
☐ The flux remains constant.
☐ The flux goes to zero.

4. A spherical surface surrounds a point charge \( q \). Describe what happens to the total flux through the surface if the volume of the sphere is doubled.

☐ The flux is tripled.
☐ The flux decreases by \( 1/3 \).
☐ The flux remains constant.
☐ The flux goes to zero.

5. In the figure above, a point charge \( 1Q^+ \) is at the center of an imaginary spherical Gaussian surface and another point charge \( 2Q^+ \) is outside of the Gaussian surface. Point \( P \) is on the surface of the sphere. Which one of the following statements is true?

☐ Both contribute to the net electric flux through the sphere but only \( 1Q^+ \) contributes to the electric field at point \( P \).
☐ Both charges contribute to the net electric flux through the sphere but only \( 2Q^+ \) contributes to the electric field at point \( P \).
☐ Only \( 1Q^+ \) contributes to the net electric flux through the sphere but both charges contribute to the electric field at point \( P \).
☐ Only \( 2Q^+ \) contributes to the net electric flux through the sphere but both charges contribute to the electric field at point \( P \).
☐ Only \( 1Q^+ \) contributes to the net electric flux through the sphere and to the electric field at point \( P \) on the sphere.
☐ Only \( 2Q^+ \) contributes to the net electric flux through the sphere and to the electric field at point \( P \) on the sphere.
☐ I don’t know (this answer is worth \( 1/10 \) of full credit)