1. Consider the electric field of a point charge

\[ \mathbf{E} = \frac{1}{4\pi \varepsilon_0} \frac{\hat{\mathbf{r}}}{r^2} \]

Which of the following are true?

A) \( \frac{\partial E_x}{\partial y} = \frac{\partial E_y}{\partial x} \)

B) \( \frac{\partial E_y}{\partial z} = \frac{\partial E_z}{\partial y} \)

C) \( \frac{\partial E_z}{\partial x} = \frac{\partial E_x}{\partial z} \)

D) \( \frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z} = 0 \)

E) All of the above

F) None of the above
2. A spherical shell of radius R carries a uniform surface charge density \( \sigma \). What is the electric potential at \( r < R \)?

A) zero

B)

\[
\frac{1}{\epsilon_0} \frac{R^2 \sigma}{r}
\]

C)

\[
\frac{1}{\epsilon_0} R \sigma
\]

D)

\[
\frac{1}{4\pi\epsilon_0} \frac{\sigma}{R}
\]
3. A spherical shell of radius $R$ carries a uniform surface charge density $\sigma$. What is the force on a test charge $Q$ at the point $r < R$?

A) $\text{zero}$

B) \[
\frac{Q R^2 \sigma}{\varepsilon_0 r^2}
\]

C) \[
\frac{Q}{4\pi\varepsilon_0 \sigma}
\]

D) \[
\frac{Q \sigma}{4\pi\varepsilon_0 R^2}
\]
4. Consider a thin surface that is a boundary between two regions in space, the region above the boundary and the region below. The surface may or may not carry charge density $\sigma$. Which of the following is true?

A) 
$$E_{\text{above}}^\perp - E_{\text{below}}^\perp = \frac{\sigma}{\varepsilon_0}$$

B) 
$$E_{\text{above}}^\parallel = E_{\text{below}}^\parallel$$

C) 
$$E_{\text{above}} - E_{\text{below}} = \frac{\sigma}{\varepsilon_0} \hat{n}, \text{ where } \hat{n} \text{ is the unit vector normal to the surface}$$

D) 
$$V_{\text{above}} = V_{\text{below}}$$

E) 
$$\frac{\partial V_{\text{above}}}{\partial n} - \frac{\partial V_{\text{below}}}{\partial n} = -\frac{\sigma}{\varepsilon_0}$$

F) All of the above