Concept Question: Flux

The electric flux through the planar surface below (positive unit normal to left) is:

1. positive.
2. negative.
3. zero.
4. Not well defined.
Concept Question Answer: Flux

Answer: 2. The flux is negative.

The field lines go from left to right, opposite the assigned normal direction. Hence the flux is negative.
Concept Question: Flux thru Sphere

The total flux through the below spherical surface is

1. positive (net outward flux).
2. negative (net inward flux).
3. zero.
4. Not well defined.
Concept Question Answer: Flux thru Sphere

Answer: 3. The total flux is zero

We know this from Gauss’s Law:

\[ \Phi_E = \oiint_{\text{closed surface } S} \vec{E} \cdot d\vec{A} = \frac{q_{\text{enclosed}}}{\varepsilon_0} \]

No enclosed charge \(\rightarrow\) no net flux.
Flux in on left cancelled by flux out on right
The grass seeds figure shows the electric field of three charges with charges +1, +1, and -1. The Gaussian surface in the figure is a sphere containing two of the charges. The electric flux through the spherical Gaussian surface is

1. Positive
2. Negative
3. Zero
4. Impossible to determine without more information.
Concept Question Answer: Gauss’s Law

Answer 3: Zero. The field lines around the two charged objects inside the Gaussian surface are the field lines associated with a dipole, so the charge enclosed in the Gaussian surface is zero. Therefore the electric flux on the surface is zero.

Note that the electric field $E$ is clearly $NOT$ zero on the surface of the sphere. It is only the $INTEGRAL$ over the spherical surface of $E$ dotted into $dA$ that is zero.
We just saw that in a solid sphere of charge the electric field grows linearly with distance. Inside the charged spherical shell at right (r<a) what does the electric field do?

1. Zero
2. Uniform but Non-Zero
3. Still grows linearly
4. Some other functional form (use Gauss’ Law)
5. Can’t determine with Gauss Law
Concept Question Answer: Flux thru Sphere

Answer: 1. Zero

Spherical symmetry
→ Use Gauss’ Law with spherical surface.
Any surface inside shell contains no charge
→ No flux
  \[ E = 0! \]
Concept Question: Superposition

Three infinite sheets of charge are shown above. The sheet in the middle is negatively charged with charge per unit area $-2\sigma$, and the other two sheets are positively charged with charge per unit area $+\sigma$. Which set of arrows (and zeros) best describes the electric field?
Answer 2. The fields of each of the plates are shown in the different regions along with their sum.

- **Field of Middle Plate:** $+\sigma$
- **Field of Left Plate:** $-2\sigma$
- **Field of Right Plate:** $+\sigma$
- **Superposition:** Zero