Chapter 21: For Thought and Discussion Answers

1. No, because the direction would then be ambiguous. (An exception occurs in pathological cases where the field goes to zero along a field line; two lines can cross at such a *null point* because there's no direction associated with zero field.)

2. No; all that matters is that the integral of $\vec{E} \times d\vec{A}$ is zero over the entire surface. That requires some field lines going in and some going out—as befits a region containing positive and negative charge in equal amounts so that the enclosed charge is zero.

3. There's no mass within the surface. And, unlike the electric case where there could be positive and negative charge within the surface, there's only one kind of mass, so the interior of the surface can't contain any matter.

4. Only when the field is perpendicular to the surface at every point, and the field magnitude doesn't vary over the surface.

5. The number of field lines wouldn't change (if it did, that would violate Gauss's law). However, the field magnitude and direction at different points on the surface would change.

6. No; once it got moving, its inertia would cause its trajectory to deviate from the field line. In terms of Newton's second law, the direction of an object's motion need not be in the direction of the force acting on it.

7. No; $\vec{E}$ is the field arising from *all* sources, whether or not they're inside the Gaussian surface.

8. It contains a net positive charge. You can tell because field lines begin within the region. Equivalently, draw a cubical Gaussian surface around the region; the stronger field at right means there's a net positive flux emerging from the cube, so the net charge enclosed must be positive.

9. It doesn’t change. Outside *any* spherically symmetric charge distribution, the field is exactly the same as that of a point charge located at the center.

10. It’s not a violation of the inverse-square law because the field is the superposition of the fields of all charges along the line. Because the line is infinite, you can never get far from it compared with its length and so, unlike the case of a finite line, it never resembles a point charge.

11. Because the field lines don’t go straight out from the cube’s faces (except, approximately, right near the cube surface). Furthermore, the field magnitude isn’t constant over a cubical Gaussian surface.

12. Nothing at all happens. The uniformly charged shell contributes nothing to the field within itself, regardless of how much charge is on it.

13. Gauss’s law applies—as it does to *any* closed surface, regardless of its shape. But this wouldn't be a useful surface for computing the field because you can’t use it to reduce the flux integral to a simple multiplication, and thus you can’t solve for E.

14. They’re identical. The field outside any spherically symmetric charge distribution is exactly the same as that of a point charge located at the center.

15. If the field weren’t zero, charges in the conductor would experience electric forces and would accelerate. That’s not equilibrium!

16. In equilibrium, charge distributes itself on both surfaces of the sheet, and the superposition of those two charged sheets gives twice the field of a single charged sheet.