

## Physics 161: Electrostatics Chapters 21-24

### Study Guide

Here is a list of questions which I have compiled by leafing through your textbook.

1. What is Coulomb's law?
2. What is the principle of superposition?
3. What is meant by a "point" charge?
4. If the separation between two point charges is doubled, how does the force between them change?
5. If the coordinate locations of two charges are specified, and the magnitude of the charges is given, can you write down an expression for the force of one charge on the other? (As a vector.)
6. What is the charge on an electron? What is the charge on a proton?
7. What is the mass of an electron? What is the mass of a proton?
8. Can you place three charges on a line such that the force on any one of them by the other two is zero?
9. What is value of the permittivity of free space?
10. How can you charge a conductor by induction?
11. How is the electric field defined? What are its units?
12. Given the magnitude of several point charges, and their coordinate locations, can you calculate the vector  $\vec{E}$  at some point  $(x,y)$ ?
13. Once you know  $\vec{E}(x,y)$ , can you find the force on a charge  $q$  were that charge to be placed at the position  $(x,y)$ ?
14. What are the "lines of  $\vec{E}$ "? Can you sketch these for some particular cases? Does the line density have any meaning?
15. What is a dipole? What are the lines of  $\vec{E}$  for a dipole?
16. Can you calculate, by brute force integration, the electric field from a continuous distribution of charge?
17. What is the electric field due to an infinite sheet of charge having a uniform density?
18. What is the electric field due to an infinite line of charge?
19. What is the electric field due to a charged ring, along a line perpendicular to the ring, passing through the center?
20. What is the electric field due to a charged disk?
21. When does the charged disk mimic an infinite plane?
22. A line of charge extends along the  $x$  axis, from  $-\infty$  to  $x=0$ . Can you calculate the electric field at some point  $x$  to the right of the origin?
23. What is meant by electric flux  $\Phi$ ? Given an expression for an electric field  $\vec{E}$ , can you calculate  $\Phi$  through a surface?
24. What is Gauss's law?
25. Use Gauss's law to find the electric field due to a point charge. Is Gauss's law equivalent to Coulomb's law?
26. Use Gauss's law to find:

- (a) the electric field due to a uniformly charged spherical shell, both inside and outside the shell.
  - (b) the electric field due to an infinite uniformly charged cylindrical shell, both inside and outside the shell.
  - (c) the electric field due to an infinite plane of charge.
  - (d) the electric field due to a uniformly charged sphere, both inside and outside.
  - (e) the electric field due to an infinite uniformly charged cylinder, both inside and outside.
  - (f) the electric field due to an infinite planar slab of charge, both inside and outside the slab.
27. Use Gauss's law to prove that the charge in a conductor always resides on the surface of the conductor.
  28. Use Gauss's law to find the electric field for a capacitor:
    - (a) two parallel plates
    - (b) two concentric cylinders
    - (c) two concentric spherical shells.
  29. What is electrical potential energy? What is electrical potential?
  30. What are the units of a volt?
  31. How much energy is required to move a particle of a certain charge  $q$  through a potential difference  $\Delta V$ ?
  32. What is an equipotential surface? How is this related to a contour line on a topographic map?
  33. How are equipotential surfaces related to lines of electric field? If given a set of field lines, can you construct a set of equipotential lines? Vice versa?
  34. What is the potential due to a point charge?
  35. If the coordinates of several point charges are given, and the magnitudes of these charges are given, can you calculate the potential at some arbitrary location  $(x,y)$ , with the reference that the potential at infinity is zero?
  36. A parallel plate capacitor is charged so that  $Q$  is on one plate, and  $-Q$  is on the other. Given the plate area and the plate separation, calculate the potential difference between the two plates.
  37. Repeat 36 for two concentric cylindrical conducting shells, one of radius  $a$  and the other of radius  $b$ .
  38. Repeat 36 for two concentric spherical conducting shells, one of radius  $a$  and the other of radius  $b$ .
  39. How much work is required to bring several charges together from infinity?
  40. A parallel plate capacitor is charged to a voltage  $V$ . If an electron is released from the positive plate, how fast will it be moving when it gets to the negative plate?
  41. A capacitor consisting of concentric spheres is charged to a voltage  $V$ . Same question as 40.

## 42. Series and parallel combinations of capacitors.