8.02 ESG Independent Study

Unit 2: Gauss’s Law

Together, Coulomb’s law, the vector nature of electric forces, and the super-
position principle allow us to calculate (in principle) the resultant electric
field from any charge distribution. The $1/r^2$ dependence in Coulomb’s law
allows an elegant way to relate the electric field to the charge by use of the
electric flux. Mathematically, Coulomb’s law and Gauss’s law are equivalent,
but which is most readily applicable depends on the circumstances. The field
due to a uniformly charged sphere is found immediately from Gauss’s law,
whereas use of Coulomb’s law requires a few pages of algebra and nerves of
steel. Conversely, Gauss’s law is not readily usable for finding the field due
to a dipole (although it can be done with some sneaky mathematics), while
Coulomb’s law and a bit of simple calculus give the result quickly.

The concept of flux of a vector through an area is a needed and in some
sense intuitive one. The flow of particles across a surface is easily quantified
in terms of an integral, and a similar flow of charged particles is a current. In
later chapters, we will relate various fields with various fluxes, but for now
we’ll deal with fields due to stationary charges and the accompanying fluxes.

Objectives: After completing this unit, you should be able to calculate
electric fields from specified charge distributions or find the charge distribu-
tion that corresponds to a given electric field, and calculate electric fluxes in
simple situations.

Suggested Procedure:

1. Read in UP11, chapter 22, and do problems 2, 11a, 17, 32abc, 36, 39,
   40, 45, 57, 63, 66 (optional; the physics is not hard, but the algebra
   gets involved.), or

2. Read the rest of Purcell, chapter 1 (again, the sections involving elec-
trostatic energy will be used in later units) and do problems 3, 15, 18,
   21, 22, 27 and 31 (pp 34–38).

3. Take a unit test.