Electromagnetism (PHYS 295): Week 2

Spring 2024 v1.5

Intro:

Chapter 2 does two things: There is the development of the electric potential ϕ and its use in determining the electric field. And there is the development of vector calculus. We will discuss the gradient and divergence now and postpone the discussion of curl until the physics demands it. Appendix F adds more discussion on the calculus, including listing important relations in the different coordinate systems.

Reading:

- PM Chapter 2, sections 1-13 (We will return to curls when we get to magnetics.)
- PM Appendix F

Problems: Due Friday February 3rd at the start of class

(1) 1.69 Superposition!

(2) Find the electric flux through a disk which has a radius of 5.00 cm and has a normal tilted 60.0° away from the direction of a uniform electric field of strength 150 N/C.

(3) In class we discussed the field diagram of a configuration of a $-2q$ charge and a $+q$ ($q > 0$) charge placed a distance $d = 1$ m to the right of the $-2q$ charge. Using the 'rotate the stars' method to more accurately represent the field carefully re-draw the field line diagram of the electric field. Please
   - use 8 lines on the $+q$ charge
   - make sure the lines are consistent with the $-q$ net charge
   - include directions on every line
   - indicate where the electric field vanishes. You can use our solution from class.
   - check that your diagram is symmetric around the line between the two charges

(4) 1.63 (a)

(5) 1.72 Planar Gauss law example

(6) 1.76 (2 pts.)

(7) 2.12 - The ring of charge returns

(8) **Kelvin Water Dropper**: The "mysterious" Kelvin Water Dropper which, as demonstrated in class, is capable of creating a large buildup of charge. When the electric field between the brass spheres is high enough, we observed electrical breakdown - a spark - in the gap. This spark occurred at roughly 20 s intervals as the water flowed. Using text and field diagrams explain this phenomenon. *Hints: Assume an initial slight asymmetry of charge between the two buckets. Tap water is a good conductor. Follow the charge as the drop forms and splits off from stream of water. Carefully draw the electric field lines around the cylinder as a drop forms. Explain how the large electric fields are generated.*