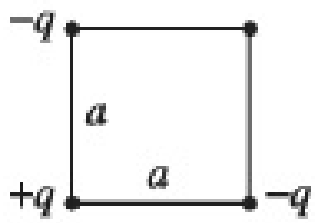
PHY209 Electromagnetism
Assignment 2
Handed out: August 18, 2019

Problem 1

(a) Twelve equal charges, q, are situated at the corners of a regular 12-sided polygon (for instance, one on each numeral of a clock face). What is the net force on a test charge Q at the center?
(b) Suppose one of the 12 q's is removed (the one at "6 o'clock"). What is the force on Q? Explain your reasoning carefully.
(c) Now 13 equal charges, q, are placed at the corners of a regular 13-sided polygon. What is the force on a test charge Q at the center?
(d) If one of the 13 q's is removed, what is the force on Q? Explain your reasoning.

Problem 2



(a) Three charges are situated at the corners of a square (side a), as shown in Figure. How much work does it take to bring in another charge, $+q$, from far away and place it in the fourth corner?
(b) How much work does it take to assemble the whole configuration of four charges?

Problem 3

Two positive point charges, q_A and q_B (masses m_A and m_B) are at rest, held together by a massless string of length a. Now the string is cut, and the particles fly off in opposite directions. How fast is each one going, when they are far apart?

Problem 4

Consider an infinite chain of point charges, $\pm q$ (with alternating signs), strung out along the x axis, each a distance a from its nearest neighbors. Find the work per particle required to assemble this system. [Partial Answer: $-\frac{\alpha q^2}{4\pi\epsilon_0 a}$, for some dimensionless number α; your problem is to determine α. It is known as the Madelung constant. Hint: The power-series expansion of $\ln(1+x)$ may be of use.]

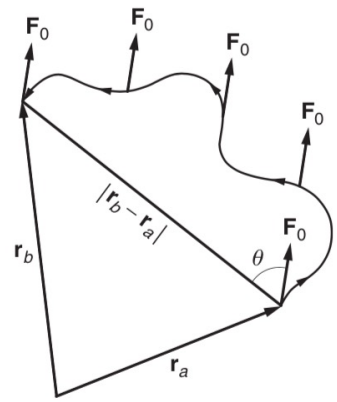
Problem 5

Show that the total potential energy of the system in Problem 2 of Assignment 1 is zero.

Problem 6

Solve Problem 3 of Assignment 1: write out the expression for the energy U of the assembly of four charges and minimize it.

Problem 7



Find the work done by a force $\boldsymbol{F} = F_0\hat{\boldsymbol{n}}$, where F_0 is a constant and $\hat{\boldsymbol{n}}$ is a unit vector in some given direction, as the particle moves from $\boldsymbol{r}_a$ to $\boldsymbol{r}_b$ along an arbitrary path.