

HW1

Equation (1.3) was derived historically from the empirical result (1.1). Do the opposite. Start from postulating that the electric field from a point charge is given by equation (1.3) and derive (1.1). Use that the energy density in an electric field is given by:

$$u = \frac{1}{8\pi} E^2$$

where the electric field \mathbf{E} is the combined field from the two charges.

The total energy in the field is:

$$U(|\mathbf{r}_1 - \mathbf{r}_2|) = \int d^3r u(\mathbf{r})$$

and the force between the charges is:

$$F = - \frac{dU(|\mathbf{r}_1 - \mathbf{r}_2|)}{d|\mathbf{r}_1 - \mathbf{r}_2|}$$

Hint: start by subtracting the individual contributions to the energy; these have infinite values for point particles. Then choose as origin for \mathbf{r} the midpoint between the two charges.