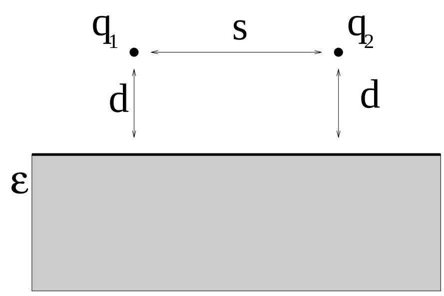
Physics 7312 | Professor Scalise
Homework Assignment #1 | Spring 2023

---

1. This problem looks easy but is very subtle – be extremely careful in your solution. The whole point is to test your understanding of what contributes to the energy and what does not.

   Two point charges q_1 and q_2, separated by a distance s, are each located a distance d from a semi-infinite slab of dielectric constant ϵ that fills the entire lower half space. Calculate the energy of the system excluding the infinite self-energies of the point charges.



2. Solve the problem above, but with the lower half space filled by a conductor. Is your answer to this problem the limit of the solution above with ϵ taken to infinity? If not, explain why not.

3. A particle of charge q_1 at instantaneous position $\vec{r}_1$ is moving in an inertial frame with velocity $\vec{v}_1$. It gives rise to a magnetic field (in cgs units) at $\vec{r}$

$$\vec{B}_1(\vec{r}) = q_1 \frac{\vec{v}_1}{c} \times \frac{\vec{r} - \vec{r}_1}{|\vec{r} - \vec{r}_1|^3}$$

   A second particle of charge q_2 at position $\vec{r}_2$ moves with velocity $\vec{v}_2$ and experiences a force due to the first particle

$$\vec{F}_{12} = q_2 \frac{\vec{v}_2}{c} \times \vec{B}_1(\vec{r}_2)$$

   (a) Show that $\vec{F}_{12} \neq -\vec{F}_{21}$ in general.

   (b) Under what conditions does the weak form of Newton's third law hold? (The weak form means that the force vectors are equal in magnitude and opposite in direction. The strong form means that in addition the force vectors are collinear.)