I Practice Problems: Work, Potential Energy, and Potential

Problem 1: Referring to the discrete distribution of charge in Fig. 1:

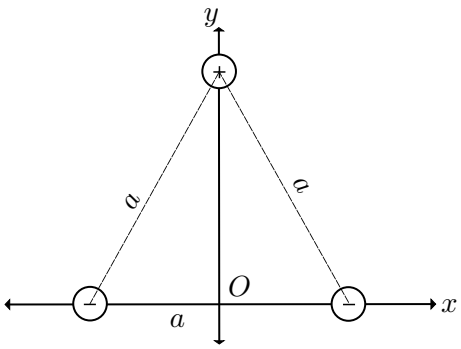

Figure 1: A discrete distribution of charges.

(i) Determine the work required to assemble the distribution of charges.

(ii) Determine the potential energy stored in the assembly of charges.

(iii) Calculate how much work would be required to move the positive charge to the origin O?

Problem 2: A random person wants to know some facts about their capacitor (as shown in Fig. 2).

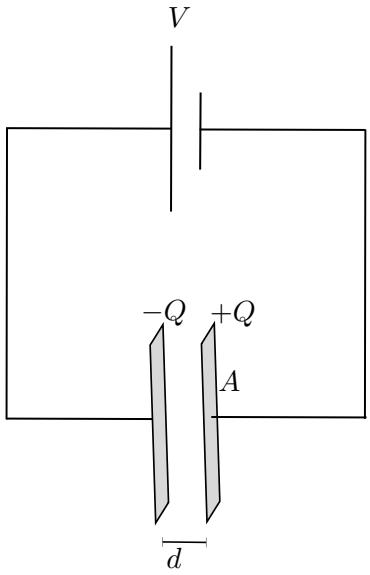

Figure 2: A simple circuit with a capacitor.

(i) Using the equation $U = \int_{\text{All Space}} u \; dV$, where the energy density is given by $u = \frac{1}{2}\epsilon \vec{E}^2$, determine the energy stored in the capacitor and compare it to that given on your equation sheet.

(ii) Now, determine the work required to move the two plates of the capacitor from d to a distance D apart, where $D > d$. (What happened to the charges stored on the plates?)

(ii) What about the work required to move the two plates of the capacitor from d to a distance a apart, where $d > a$?

Problem 3: Determine the energy density u of the charge distribution in Fig. 3 and use it to determine the potential energy stored in the charge distribution. (*Hint:* You will need to determine the $\vec{E}$ field for its different regimes. As a reminder, you should be able to recall one of them off the top of your head.)

Here are some relevant equations!

$$u = \frac{1}{2}\epsilon\vec{E}^2, \quad U = \int_{\text{All Space}} u\, dV$$

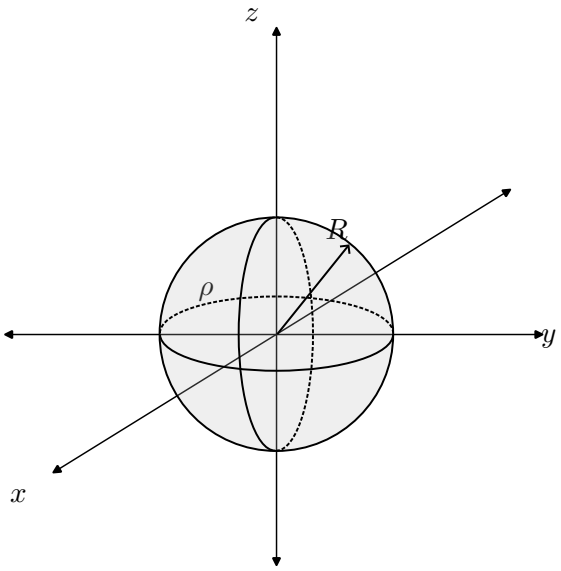

Figure 3: A spherical charge distribution.

What are your major takeaways/things that you want to remember?